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Heat Treatment of Steel Springs

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Commercial considerations—General requirements for a spring—Spring steels and their compositions—Coiling, forming and heat treating helical and leaf springs

THE complete study of metals and methods of working them has become so diverse in both its practical and scientific fields that it is difficult to determine which particular phase of the study is most important to the machine shop man. In the spring-making art, however, it is becoming more apparent each day that correct heat treatment is extremely important since the functional characteristics and the life of a spring vary considerably if this part of the work is performed improperly. Successful heat treating depends upon a knowledge of practical, up-to-date methods including an accurate and reliable system of pyrometric control, and also upon a brief knowledge of metallogy.

To generalize briefly, we know that the industrial metals, iron, copper, aluminum and others, are not given to us fully prepared for use as per our specifications. Instead, nature has made it necessary for us to appoint our own "chefs," the metallurgist, heat treater and machinist. All of their co-operative functions are directed toward the preparation of these metals to meet the requirements demanded by the particular industry involved, in this case the spring manufacturers. The user of springs naturally desires ideal results but the manufacturer must set his goal in accordance with commercial considerations. It is necessary therefore, before developing the metals from the "as found" state into the finished product, to proceed as follows:

1. To determine the general requirements irrespective of the subject of the working of metals.

2. To modify these requirements most efficiently in accordance with the principles of the working of metals and commercial considerations.

3. To subdivide the modified requirements in accordance with the technique of the metallurgist, heat treater and machinist. (In this article we shall be concerned with the technique of the heat treater of springs.)

The general requirements for a spring, assuming that the dimensional design is to be one hundred per cent correct, are as follows:

(a) Minimum and maximum limits for the rate of increase in elastic resistance, i.e. modulus of elasticity. (These limits are practically coincident except in the case of springs used at elevated temperatures and springs used in sensitive measuring instruments.)

(b) Minimum limits of elastic range of deflection which for static[1] conditions depends upon the static proportional limit and for kinetic[1] conditions upon the fatigue endurance limit and in each case for a given modulus of elasticity. In the case of springs used at elevated[1] temperatures this limit also depends upon the modulus of elasticity, which varies.

(c) Minimum limit for ultimate strength.

(d) Minimum and maximum limits for ultimate elongation and reduction of area.

(e) Minimum limit for resistance to shock as measured by various empirical tests.

Spring Steels

Before proceeding to formulate the modified requirements for steel springs, let us make a mental survey of the road which a mass of iron must travel from the ore to the finished article. Briefly, the extracted metal, while in the molten state, is first cleansed of slag, oxides of iron, sulphur and phosphorous, and mixed with small amounts of carbon, silica, manganese, and so on, by the metallurgist. Small or large amounts of chromium, molybdenum, manganese and other metals may also be added depending upon the specification to which the metallurgist is working.

In the case of steel the amount of impurities and the homogeneity of structure will depend upon the process used, of which four are available: Bessemer (basic and acid); open hearth (basic and acid); crucible; and electric furnace. Open hearth (basic), crucible and electric furnace steels are usually specified for springs. The electric furnace is gaining favor in this country, where production is large, while in Europe, where production is small, the open hearth furnace is used.

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[1]In previous articles published by the author in the *American Machinist*, the elastic range of deflection under these three conditions was shown to be measureable by the static, kinetic and high temperature material indexes respectively.

The metallurgist controls his product by pyrometric means, chemical analyses, physical tests to a slight extent and by photomicrographs of specimens. The resulting steel turned over to the heat treater will therefore have to meet a specification which calls for:

1. A definite variation of chemical constituents.
2. A clean, sound and homeogeneous structure.
3. In order to insure 1 and 2 in manufacturing springs, steel made by the open hearth (basic), crucible or electric process will be required.
4. Certain forms of material, rounds or flats, hot- or cold-drawn (or rolled) to certain limiting dimensions.

As regards 1, we usually recognize two classes of steel, carbon and special. The former contains carbon, manganese, and silica in small amounts and also the impurities sulphur and phosphorous. The latter, in addition, may contain any one or several of the following metals: excess manganese or silica, vanadium, molybdenum, chromium, or others. In the case of annealed carbon steels the ultimate strength, elastic limit and other physical properties improve progressively with an increase in carbon content up to 0.9 carbon, due to the increasing interference offered by the increasing amount of hard free cementite crystals to plastic flow of the soft ferrite crystals.

Further improvement in these properties is obtained by heat treatment in which the hardening is due to the retention or dissolving of some of the free cementite in the iron. The hardness produced by quenching is accompanied by brittleness, hence some of it has to be sacrificed. This is accomplished in drawing, which makes the steel serviceable and still allows it to retain its higher physical properties. Of course the more total carbon there is present in the steel the more free cementite will be available to dissolve in the iron, and since the general requirements for a spring call for very high physical properties, particularly the elastic limit, it is obvious that there must be a minimum carbon limit for spring carbon steels. This limit is about 0.5 per cent carbon for water-quenched springs (European practice) and 0.7 per cent for oil-quenched springs (American practice).

The upper carbon limit for water-quenched springs is 0.7 per cent and for oil-quenched springs it is 1.15 per cent. The manganese content is usually about 0.05 per cent or just a little more than enough to function as a cleanser of the steel during the refining process. The sulphur and phosphorous, being undesirable, are of course limited in quantity by the processing of the steel; in the usual spring carbon steels the maximum content is about 0.04 per cent of each constituent.

In the case of special spring steels, containing the additional alloying metals previously enumerated, certain added improvements are obtained provided the heat treatment has been correctly performed. Less carbon is required than in carbon steel to obtain a given hardness because the alloying metals form complex carbides with the carbon which goes into solution at the transformation temperature. The heat treatment of these steels must be under very good control in order to get the best results, oil being used exclusively as the quenching medium.

There are four principal steels of the special class, as follows:

1. Silica-manganese
2. Chrome-vanadium
3. Chrome-silicon
4. Chrome-molybdenum

The last-named steel, although not exactly new, is not used very extensively for springs at present. Its use is confined chiefly to certain automobile leaf springs and flat leaf spring units in flexible gears for electric locomotives. For helical springs such a steel might prove serviceable after further research in the coiling and heat treating processes. It is indeed a very clean-scaling metal, particularly adaptable for flat springs.

	Carbon Steel				Silico-Manganese Steel				Chrome-Vanadium Steel			
	A		B		A		B		A		B	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Carbon	0.85	1.05	0.90	1.05	0.45	0.55	0.55	0.65	0.45	0.55	0.55	0.65
Silicon	....	....	....	....	1.80	2.10	1.50	1.80	....	....	....	....
Manganese	0.25	0.50	0.25	0.50	0.60	0.80	0.50	0.70	0.50	0.80	0.60	0.90
Sulphur	....	0.050	....	0.050	....	0.045	....	0.045	....	0.05	....	0.05
Phosphorus	....	0.05	....	0.04	....	0.045	....	0.045	....	0.04	....	0.04
Chromium	....	....	....	....	....	....	....	....	0.80	1.10	0.80	1.10
Vanadium	....	....	....	....	....	....	....	....	....	0.15	....	0.15

NOTE: A—Flat-bar leaf and round-bar helical springs. B—Round-bar helical springs.

The compositions of spring steel bars shown in the table have been standardized by the American Society for Testing Materials.

A typical analysis of a chrome-molybdenum steel is as follows:

	Per Cent	
	Min.	Max.
Carbon	0.42	0.52
Manganese	0.75	1.00
Silica	—	0.20
Sulphur	—	0.04
Phosphorus	—	0.04
Chromium	1.00	1.20
Molybdenum	0.25	0.40

Assume, then, that the heat treater and machinist, or the spring maker who may embrace both their functions, has received his supply of steel in accordance with any of the above chemical and metallurgical specifications and also in the soft annealed condition. We shall consider the actual coiling of large helical springs and the forming of large flat leaf springs and also the corresponding heat treatments for these springs. Let it be kept in mind that only large springs which must be formed while hot and heat treated afterwards are being considered in this article. As a conclusion to this discussion the sub-division of the modified general requirements which cover the technique of the spring maker or heat treater will be outlined.

Coiling and Heat Treating of Helical Springs

Carbon Steel, 0.90 carbon

Coiling. A round bar of this steel, say 1 in. in diameter, is heated uniformly to a temperature of about 950 deg. C. in a controlled gas-fired or electric fur-

nace, notched to length and wound upon a mandrel preheated to about 200 deg. C. The coiled spring is then allowed to cool in air while on the mandrel. The mandrel is designed in accordance with the diameter and pitch of the spring being coiled. The coiling temperature must not be too high or the steel may be damaged internally (which only remelting can cure), or the surface of the spring in contact with the mandrel may be distorted. Too low a temperature may give rise to a poorly coiled spring.

Quenching. The coiled spring is put into the furnace and heated uniformly throughout by special means to 800 deg. C. and then quenched in oil. It is extremely important to have the rate of cooling uniform for all parts of the spring. Some manufacturers accomplish this result by forcing oil under pressure through the inside of the coils, the spring being supported on a cradle. The spring should be kept at a temperature above 212 deg. Fahrenheit.

Drawing. The hardened spring is next drawn at about 400 deg. C. in a salt bath for about one hour, a treatment that results in a Brinell hardness of about 375. Under ideal conditions the internal structure obtained is chiefly troosto-sorbitic.

Below are the heat-treatment temperatures for some of the special steels.

Chrome-Vanadium Steel, 0.50 carbon

	Degrees C.
Coiling temperature	1,000
Preheating to	835
Holding for ½ hr. and then cooling slowly	
Reheating to	900
and then quenching in oil	
Reheating to	450
and cooling slowly	
Brinell hardness about 387.	

Silico-Manganese Steel, 0.60 carbon

	Degrees C.
Coiling temperature	950
Hardening temperature	900
Quenched in oil	
Drawn in salt for 1 hr. at	450
and cooled slowly	
Brinell hardness about 410.	

Forming and Heat Treating of Leaf Springs

Carbon Steel, 0.95 carbon

Forming. The blade upon being sheared to length is heated uniformly in a controlled gas-fired or electric furnace to 900 deg. C. and then quickly transferred to the forming machine.

Quenching. The dies of the forming machine, while still containing the hot blade, are quenched in oil before the blade has a chance to cool to a temperature of 800 deg. Centigrade.

Drawing. The hardened blade is removed from the dies and reheated to about 450 deg. C. in a salt bath or conveyor furnace for one hour or more. It is then allowed to cool slowly in air. The resulting Brinell hardness is about 388.

Due to the enormous production of leaf springs in this country, particularly in the automotive industry, various types of conveyor systems with automatic controls have sprung up, which, beside turning out springs at a fast rate, eliminate the skilled fitter and heat treater of former days and present-day European practice. In most of these systems a definite rate of production is maintained, that is, if one sheared blade is placed in the furnace every minute a formed hardened and tempered blade is completed every minute. Some systems perform each operation on several blades simultaneously.

One type of machine used in this work has a series of adjustable fingers arranged either side of the inserted blade for obtaining the desired camber. Another, the rotary, type is used extensively for large production work in the automotive trade. In this type a blade is placed in each of the forming dies mounted on the hexagonal surfaces of a drum arranged to revolve half submerged in a quenching medium.

In the manufacture of railway springs still another type of forming machine is used most extensively. This type has a solid die on one side and a belt chain on the other side of the inserted blade. The railways also use the solid die in conjunction with the adjustable fingers.

In the methods of forming described, the blade is heated above the critical range only once, which suffices for both the forming and hardening operations. The old method, still practiced here and almost exclusively in Europe, is to heat the blade for forming and then let it cool slowly. It is then removed from the forming dies and hardened and tempered in the regular manner.

The heat-treatment temperatures for some of the special steels follow:

Silico-Manganese Steel, 0.75 carbon

	Degrees C.
Forming temperature	950
Quenched in oil when at	850
Drawn in salt at	500
Brinell hardness about 405.	

Chrome-Vanadium Steel, 0.45 carbon

	Degrees C.
Forming temperature	1,000
Preheated to	850
for ½ hr. and cooled slowly	
Hardened by an oil quench from	900
Tempered at	350
Brinell hardness about 410.	

Returning to that section of the modified requirements which concerns the heat treater, these are usually determined in the laboratory. The forming and hardening temperatures are obtained from the heating and cooling curves for the particular steel in question and then verified by a microscopical study of sections of a test spring. The drawing temperature determination is perhaps the most important of all because small variations of this temperature give rise to large variations in the physical properties. A chart is prepared on which curves showing the variation of the ultimate strength, elastic limit, elongation, Brinell hardness and charpy or Izod impact numbers for a scale of drawing temperatures are plotted.

Minimum and maximum temperature lines are then drawn on the chart between which the permissible limits for the physical properties are located. These limits will not satisfy the general spring requirements in any case but some spring metals will give a better compromise than others. Thus the sub-division of the modified general requirements covering the technique of the heat treater of springs will be as follows:

1. To form and harden the springs above the critical range but not so far above that the steel might be

damaged or the large grain size might be obtained.

2. To temper the springs at a temperature falling within the minimum and maximum temperature limits shown on the chart giving the relation between the physical properties and the temper scale.

The rate of cooling both in quenching and drawing is usually left to the judgment of the skilled worker or predetermined in the laboratory.

It is of course obvious that when setting the minimum and maximum temperature lines on the chart referred to the general requirements must be borne in mind, but in this particular case of large helical and flat steel springs paragraph "a" of these requirements is omitted.

The working fiber stress, which sets the general requirement for automobile front elliptics, is 56,000 lb. per sq.in. and for the rear springs 70,000 lb. per sq.in. For railway elliptics it is 90,000 lb. per sq.in. The fiber stress used for helical springs in the automotive industry is about 75,000 lb. per sq. inch.

Now as against these figures the temper chart for the steels considered in this article would show elastic limit of 134,000 lb. per sq.in., tensile strength of 170,000 lb. per sq.in., elongation of 6 per cent, for carbon steels. Silico-manganese steel will give the following:

Elastic limit	164,000 lb. per sq.in.
Tensile strength	192,000 " " "
Elongation	6 per cent

Chrome-vanadium steel will give the following figures:

Elastic limit	170,000 lb. per sq.in.
Tensile strength	200,000 " " "
Elongation	6 per cent

METHODS OF CONTROL

Temperature. In the production of large quantities of springs pyrometic control replaces the old rule of thumb methods. Clerks each hour record the readings of all furnace pyrometers connected by wires to the central control board. These records then are transmitted telantographically to each foreman who makes adjustments accordingly.

Checking Tests. Drillings are made on coupons notched in the bar before coiling or forming as the case may be and sent to the chemical laboratory for analysis.

Sections of a coiled spring or the blades of a leaf spring are checked for uniform heat treatment by means of the Brinell test which, beside showing consistent results, must show a number which falls within the permissible limits.

The finished spring must also not take an appreciable set when overloaded 25 per cent four times.

Production of Scales and Balances in 1923

The Department of Commerce announces that, according to data collected at the biennial census of manufactures, 1923, the establishments engaged primarily in the manufacture of scales and balances reported products valued at $24,100,602, an increase of 51.7 per cent as compared with 1921, the last preceding census year. This industry classification covers the production of scales, balances, weighing machines and apparatus, automatic and computing weighing machines, etc.

In addition, scales and balances were manufactured to some extent as secondary products by establishments engaged primarily in other industries. The value of the scales and balances thus produced outside the industry proper in 1921 was $433,193, an amount equal to 2.7 per cent of the total value of products reported for the industry as classified. The corresponding value for 1923 has not been ascertained, but will be shown in the final reports of the present census.

Flowers in a Foundry Yard

BY JACK WILLIAMS

Heaps of broken castings and rusty iron, stacks of flasks, piles of coal, coke, ashes and miscellaneous junk are more likely to be seen in a foundry yard than are flowers. The illustration shows a spot in the yard of the Farrel Foundry & Machine Co. at Ansonia, Conn.,

Flower boxes in a foundry yard

close by the big door of the foundry where hundreds of tons of iron are poured daily from four cupolas, where teams, trucks and cars are constantly passing, and where the atmosphere is contaminated with steam, smoke and gas.

Some years ago the foundry superintendent, who is a lover of flowers, had these boxes placed in the windows of the foundry office where they may be given daily attention under his supervision, and every summer there is a profusion of blossoms, despite the adverse conditions. The garden is an incentive to the yardmen to keep things picked up and their domain in order. The foundrymen, too, often stop in the morning when coming to work to admire and discuss, and possibly to "pinch" a blossom or two, which may have its effect upon their daily output of molds.

Analyses of Uma Steels

We are informed by the Central Steel Co., Massillon, Ohio, that the analyses of Uma steels, given on page 221, Vol. 61, of the *American Machinist*, were not exact in all particulars. We give herewith the analyses of the seven specification numbers.

Analyses of Agathon Uma Steels

SPEC. No.	Carbon Min. & Max.	Mang. Min. & Max.	Phos. Max.	Sul. Max.	Nickel Min. & Max.	Chrom. Min. & Max.
UMA-1	0.10—0.20	0.35—0.65	0.04	0.04		0.55—0.75
UMA1B	0.10—0.20	0.35—0.65	0.04	0.04	0.40—0.60	0.40—0.60
UMA2	0.28—0.33	0.60—0.80	0.04	0.04		0.85—1.00
UMA3	0.33—0.37	0.70—0.90	0.04	0.04		0.80—1.10
UMA4	0.42—0.47	0.70—0.90	0.04	0.04		0.85—1.10
UMA5	0.47—0.52	0.70—0.90	0.04	0.04		0.85—1.10
UMA5	0.47—0.52	0.80—1.00	0.04	0.04	Spring	1.00—1.20

Locomotive Repairs in New Burlington-Denver Shops

By Howard Campbell
Western Editor, *American Machinist*

New Burlington shops near Utah Junction now in operation—Time-saving tools and fixtures are features in the new shops — Details as to special tools and methods

THE RECENT completion by the C. B. & Q. R.R. of a $3,000,000 plant near Utah Junction, Denver, Colo., marks an epoch in transportation history in the Rocky Mountain region. The new shops provide first-class facilities for repairs to Burlington locomotives and will also take care of heavy repairs on locomotives for the Colorado & Southern, which is a subsidiary of the Burlington road. The main building, which houses the machine and erecting shops, is 243 ft. wide by 509 ft. long, so constructed that the erecting bay is in the center with machine bays on either side. Three pit tracks extend the length of the erecting bay, which is served by two Whiting 125-ton cranes and one Pawling & Harnischfeger 15-ton crane. The heavier machine work is done in the east machine bay, while the lighter machines, together with the tool-room, air-room, electrical, superheater and brass departments are located in the west bay. The heavier machines are served by two Pawling & Harnischfeger 15-ton cranes and many of the machine tools have individual Conco 2-ton cranes equipped with either Wright chain-hoists or Sprague electric hoists. All machine tools are equipped with individual motors with push-button control.

Fig. 1—Tool-forging and tempering department

The boiler shop is of ample size to handle all boiler work and is well equipped with the latest types of machinery, including an electric flue-welder. The blacksmith shop is also of ample proportions and is equipped with the latest types of Chambersburg steam hammers and an Ajax forging machine. All steam hammers are equipped with Conco cranes.

The machine shop equipment is arranged according to the group system, a complete set of machines being allotted for the production of each of the major parts. The policy of the shop is to finish, as far as possible, all parts in the machine shop and deliver them to the erecting floor ready to be assembled. In the wheel department all work in connection with driving wheels, including the fitting and application of eccentrics, eccentric cranks and driving boxes as well as all work on engine trucks and trailers, is completed, and these parts are delivered to the erecting shop ready for application. This system also applies to side and main rods, link motion pistons, crossheads, valves, brake rigging, spring rigging, cab trimming, cabs, pipe work, steam pipes and superheater units. It is a standing order that every part that is removed from a locomotive when it is stripped shall be thoroughly overhauled in the machine shop before being reassembled to the engine. This saves a considerable amount of time that would otherwise be lost by foremen and workmen going back and forth between the machine shop, blacksmith shop, boiler shop and erecting shops.

In the heavy machine bay a first-class machinist is assigned to the job of laying out all new work in connection with Walschaert valve gear and other work of that nature, in the process of which he makes such templets and jigs as are necessary and which results ultimately in the saving of a considerable amount of time. It is intended that the erecting shop shall devote its time exclusively to stripping and assembling. The machine shop is equipped throughout with Boye and Emmes geared-head motor driven lathes of the latest pattern.

An interesting feature of the shop is the manner in which forged tools are handled. With the idea that tool-smiths are more closely allied with the tool department than with the forge shop, complete equipment for forging and heat-treating tools has been installed

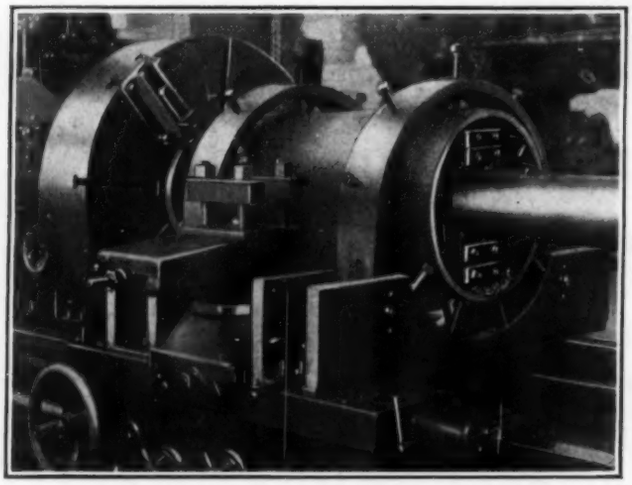


Fig. 2—Boring a cylinder bushing

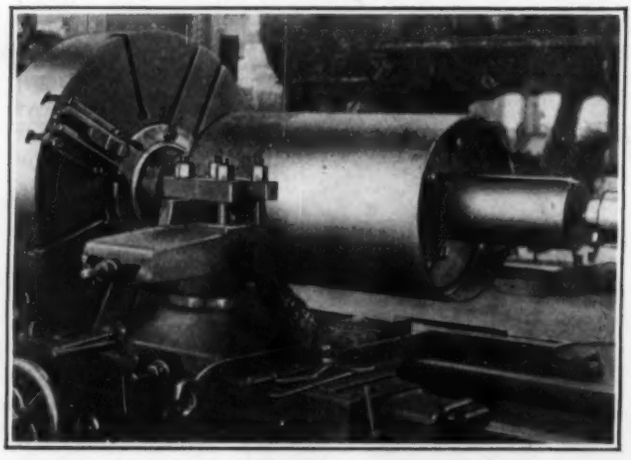


Fig. 3—Turning the bushing after boring

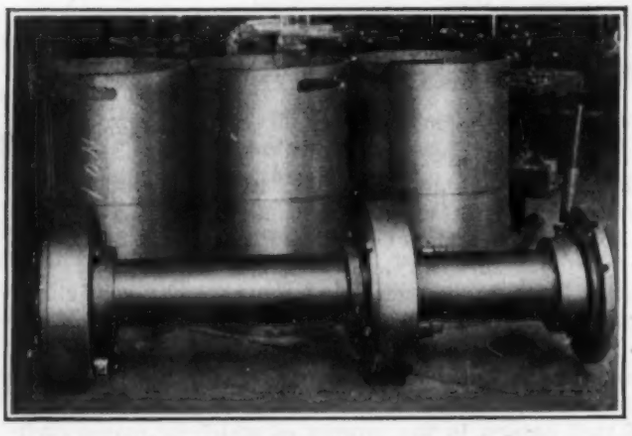


Fig. 4—Expanding mandrel and finished bushings

in one corner of the tool-room, as shown in Fig. 1. A forge, anvil, power-hammer, and two Hoskins electric furnaces complete the equipment. Tool-stock is cut to length in a Peerless high-speed saw.

Although the shop has been in operation but a short time, a number of interesting tools and methods have been developed. One of the more interesting fixtures is that for use in boring cylinder bushings, Fig. 2. The machine is a Betts-Bridgeford 48-in. lathe and the bushing is located in a fixture that is bolted to the carriage of the machine as shown. The casting is supported at the ends by bolts in the base of the fixture and is locked in position by bolts in two radial clamps, each of which is hinged at one end and locked by a pin at the other. The bolts can be adjusted so that the casting is supported on all sides. There are two cutting tools, each of 1x2-in. high-speed steel, located in a head that is supported by a bar with a flange on one end that is bolted to the face-plate and is supported by the tail-stock center in the other end. The bar revolves with the tools while the casting is fed along on the carriage. A heavy roughing cut is taken, which is

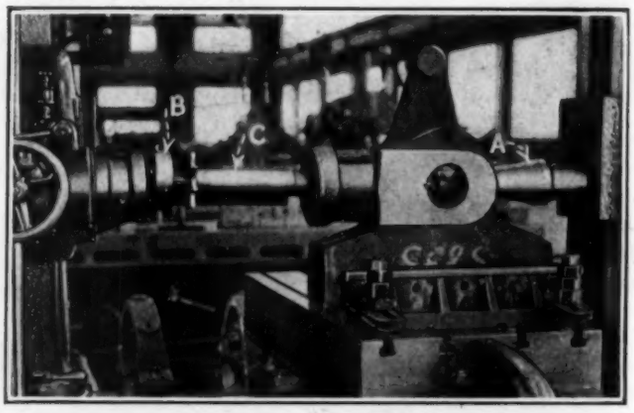


Fig. 5—Boring taper hole in crosshead

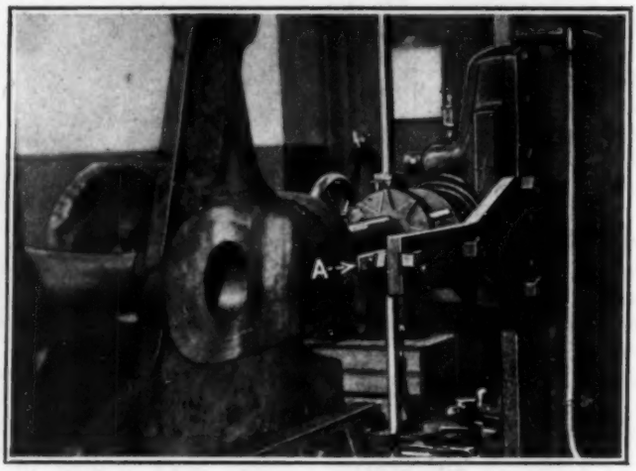


Fig. 6—Rear view, showing feed mechanism

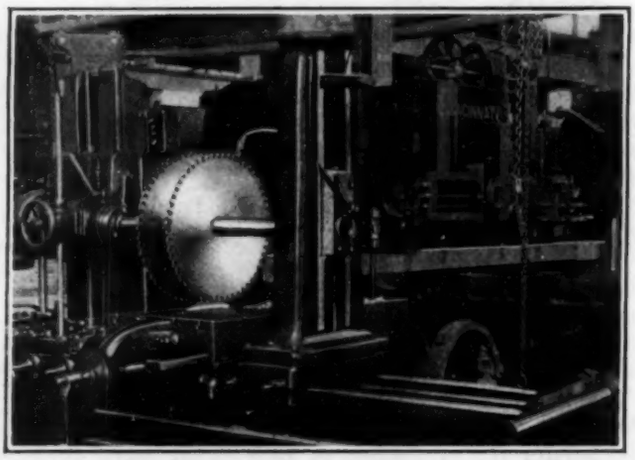


Fig. 7—Sawing out end of main rod

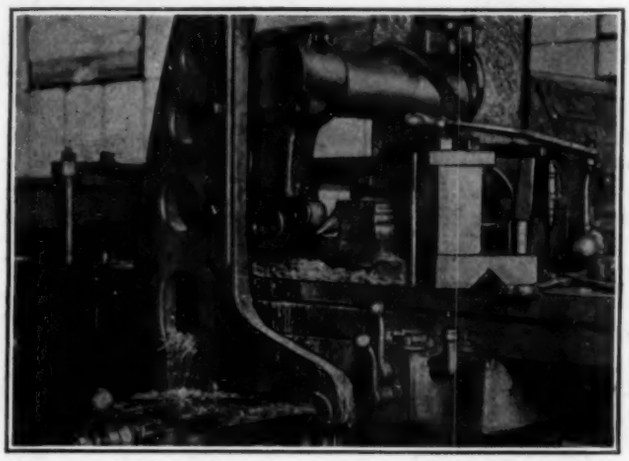


Fig. 8—Machining closed end of rod

divided between the two tools, just enough stock being left for a very light finish cut.

After the bushing has been bored, it is put on an expanding mandrel and is turned to size as shown in Fig. 3. The mandrel, which can be seen in Fig. 4, has a flange for driving purposes and carries two solid heads that are turned taper to correspond with the taper on the inside of the slip-rings that engage the inside of the bushing. Each ring is slotted so that it can expand when drawn up on the taper by the action of tightening the nuts on the lock-bolts. Thus the periphery of the bushing is turned true with the hole, producing a wall of uniform thickness. Completed bushings are also shown in Fig. 4.

Another interesting job is that shown in Fig. 5, where a crosshead of the Laird type is set up for machining in a Blomquist-Eck horizontal boring machine. The tool shown in the machine was designed especially for boring out the taper hole for the piston rod fit and crosshead pin fit and carries a ⅜x1-in. high-speed steel tool. The tail end of the boring bar is held on a center in the end of the bar *A*, while the head end is attached to an adjustable slide in the head *B*, which in the present instance is set to produce a taper of ¾ in. to the foot. The sleeve *C*, which is attached to the star at one end and to the section that carries the tool at the other end, is threaded to fit the square thread on the bar. As the bar revolves with the machine spindle, the star strikes the rail *A*, Fig. 6, and feeds the tool into the hole. A crosshead for a 4½-in. piston rod can be bored for the piston-rod fit, the crosshead-pin fit can be bored, the end faced for the piston rod, both ends of the piece faced to length, and inside cheeks faced in considerably less than the time that was formerly required when the job was done on a boring mill.

The Blomquist-Eck machine is also used to saw out the ends of the main rods as shown in Fig. 7. The rod is a forging and the cutters are two 26x¼-in. inserted-tooth Simonds saws. The rod is laid out and holes are drilled at the inner end of the block that is to be taken out, then the rod is set up as shown and the saws finish the job. Cutting compound is used to facilitate the cut. The closed end of the rod is machined out as shown in Fig. 8, using a Kempsmith milling machine and an Ingersoll 2-in. cutter of left-hand spiral. The rod is laid out and a hole is drilled through which the cutter can be inserted, then the cutter follows the layout line.

A New Journal-Turning and Quartering Machine

A 90-in. Putnam journal-turning and quartering machine that has been developed recently is shown in operation in Fig. 9, turning the pins on a pair of driving wheels. The machine is particularly interesting because of the fact that the design is new and embodies a number of interesting features, one of which is the tailstock center, which revolves on ball bearings. The use of such a center eliminates the possibility of wear in the center-holes in the axles. A double carriage base is provided on the bed of the machine to handle the turning and burnishing of the journals and for facing hub liners. Each carriage is fitted with an apron and both longitudinal and cross feeds—both reversible—are readily obtainable. For turning trailer journals,

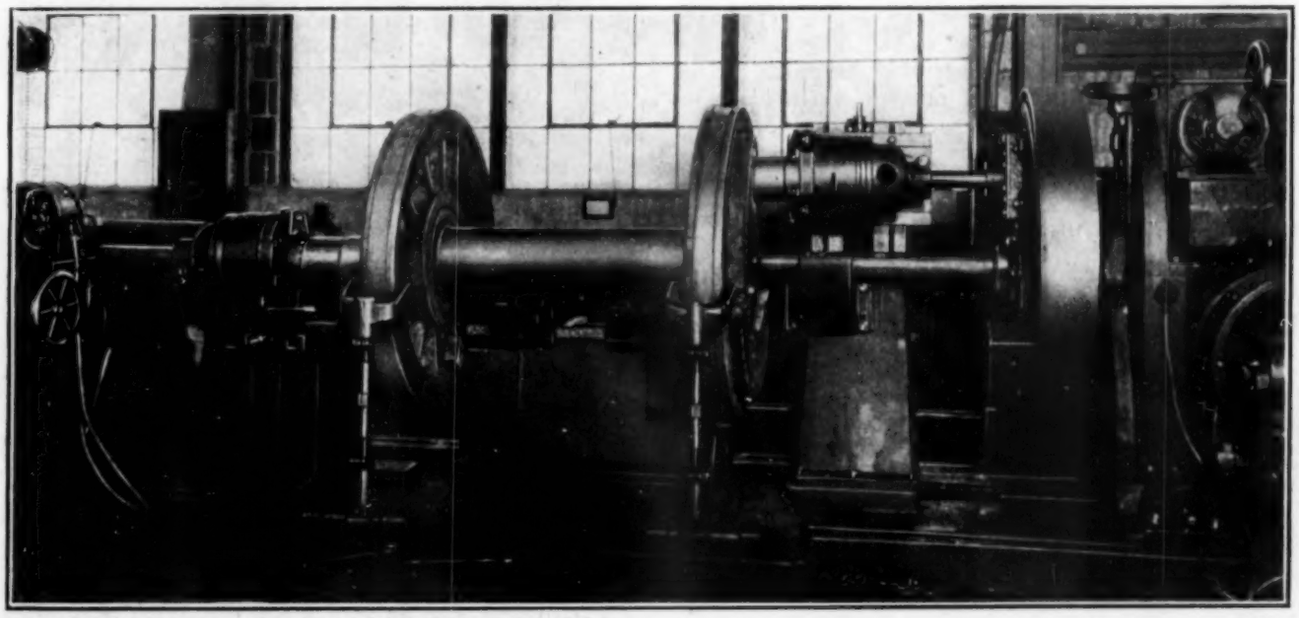


Fig. 9—Turning a pair of crank pins, using new type Putnam journal-turning and quartering machine

a single-head carriage base is located adjacent to the tailstock, provision being made for power feed. In order that the tailstock may be brought up close when handling driving sets, the single trailer-journal carriage is so arranged that it can be swung around out of the way. A pivot member is bolted to the bed of the machine and a capstan wheel is provided so that the carriage base can be raised enough to clear the ways and allow the tongue to clear the groove in the bed. The crank pin turning attachments are of the sleeve type, with two tools mounted in each sleeve. The tool bits are held on adjustable plates so that they can be easily set for the various sizes of pins, and each sleeve revolves in a bearing that affords ample support and rigidity.

The faceplate of the machine carries two counterweights, bolted to a circular T-slot near the circumference of the faceplate, making it possible to balance quickly any driving-wheel set. An internal ring gear is attached to the front face of the faceplate and each counterweight carries a small pinion that engages the ring gear, a square being provided on the outer end of each pinion shaft for the reception of a crank, which makes it possible to adjust the counterweight quickly and easily.

(To be concluded.)

Standardizing Springs for Agricultural Machinery

BY HERBERT F. CRAWFORD

The International Harvester Co. has been interested in standardization for a number of years and is one of the leaders in this work as applied to its own products. As with all large corporations operating a number of plants they have been absorbed from time to time, much diversity of practice was found between the different plants. As is usual in such cases, there were many designs for parts that performed the same function in machines built in the different shops.

It is no easy matter to change the sizes even of bolts and nuts in a number of plants, on account of the question of replacement, or service as we are now calling it. But the management realized that standardization was necessary and began several years ago to accomplish the desired work in a quiet way.

EACH DESIGNER A LAW UNTO HIMSELF

To Maj. O. B. Zimmerman was given the task of harmonizing the varying practices along the lines of least resistance. One of the first subjects attacked was that of springs. Each plant made its own springs and there were comparatively few duplicates, because each designer seemed to have worked along different lines.

After considerable study, sample boards were made of the springs made and used at the different plants. The McCormick board is illustrated herewith. Each spring is tagged with a part number which identifies it as belonging to a certain machine.

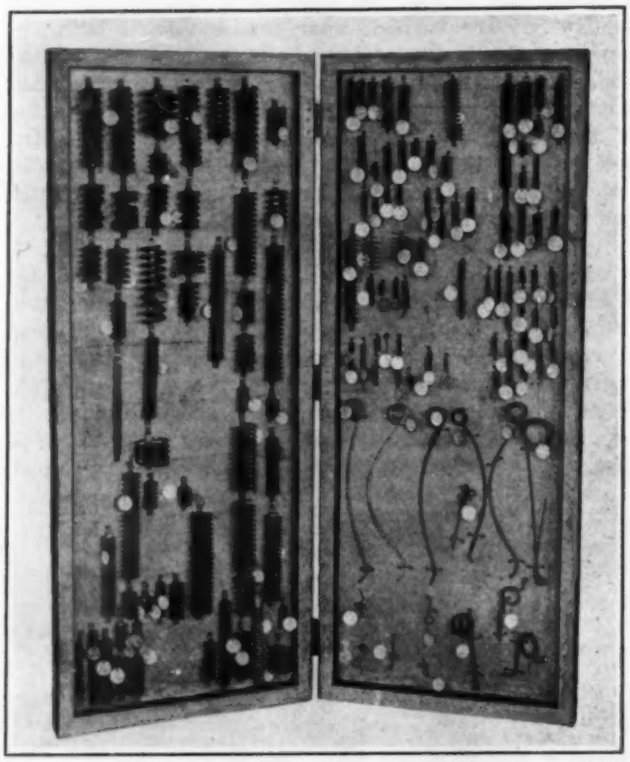
To illustrate what has been done with only one of the many machine elements—coiled wire springs of the round-wire, tension and compression types—we may mention the following standardization:

1. Establishment of definitions of terms peculiar to that product.
2. Specification of material used to cover steel wire.
3. Reduction of wire gages used from 6 to 1.
4. Reduction in wire sizes from 51 to 31.
5. Concentration of spring manufacture in one works.
6. Establishment and unification of heat treatments.
7. Reduction in design methods from 7 to 1.
8. Development of design tables, covering strength, load and coil diameters, with safe ratios to use for avoiding material waste.
9. Establishment of standard spring ends, thus reducing breakage.
10. Establishment of fatigue values to accord with spring operation.
11. Establishment of standard drawing of springs at all works.

The reduction in numbers of springs from over 800 is under way, and the establishment of a series of preferred springs has begun.

The above is an example of what can be done with intra-company standardization of one of the hundreds of possible machine elements. It represents notable savings when considered in terms of more than 3,000 tons of springs used yearly.

The sample boards are a constant object lesson to designers who are urged to utilize the types and sizes



Sample board of standardized springs

of springs already in use, on new machines if it is at all possible to do so.

Any addition to the list is "taboo" unless it is unavoidable. Elimination of some of the existing sizes and the adoption of such other standard springs as are suitable, is the aim of those who wish to simplify the spring practice and reduce spring cost. This method of dealing with the spring problem is suggestive of other parts of machine work that could probably be handled in a similar manner. There are opportunities for similar savings in almost any large manufacturing plant.

How Much Are Inefficient Machines Costing You?

By K. H. Condit
Editor, *American Machinist*

Machine equipment sets production limits—Keeping track of the cost of inefficient machines—Cost data show when to throw out obsolete equipment

THE job of the superintendent or production manager (the exact title does not matter) in a modern manufacturing plant is to get out production of a quality that will meet the given specifications at minimum cost. Of the various factors affecting the final result none is more important than the type of machine equipment available. The old adage that a good workman can produce better work with poor tools than a poor workman with good tools still holds but there is no longer any reason why the best workmen should not be provided with the best possible tools. The tools are on the market and at a price so low, in most instances, that the saving in production costs brought about through the introduction of a new piece of machinery will pay for the machine in a period of months rather than years.

It is unfortunate, but nevertheless true, that many a superintendent or works manager is up against the problem of proving to the financial management that it will be money in their pockets to invest in modern tools. The constant demand on the production man is for lower unit costs. Unless he can provide cold figures to back up his requests for better machines to accomplish the desired results his case is not a happy one.

Various methods have been devised to show the poor economy of using obsolete or inadequate equipment, some of them good, others not so good. At the Hess-Bright plant of the SKF Industries, where high grade automobile and industrial ball bearings are made in large quantities, the management has devised a system of keeping track of the cost of inefficient machinery that is well worth studying.

When an order comes in it is sent to the planning department, which is familiar with every machine in the plant and can schedule the work to the best advantage. If forgings are needed they are ordered in time to be annealed and ready when the machine, or battery of machines, that is to perform the first operation is released by the completion of the preceding order.

Enough machines must be scheduled to the job to produce the required number of pieces per day in order that the predetermined monthly schedule may be met. Clerks in what is known as the "soft side" of the planning department, in other words those interested in the work before it reaches the hardening process, see to it that material is delivered to the various machines as they need it. As the output of the plant, about 100,000 assemblies per month, requires that some 1,800,000 pieces be in process continuously, there is considerable opportunity for occasional jams to develop. Where one does occur it is reported at once to the production manager who straightens it out himself.

Each week the production manager receives a report, "Weekly Summary of Operation and Inspection," on all sizes of bearings. The accompanying line cut shows the form used. On this report appears the item of cost of inefficient machinery.

The item is obtained in this way: When a number of varying orders are in process through the plant it often happens that the most efficient machine for a given operation is engaged on some other operation. If such is the case it becomes necessary to schedule some less efficient machine to the operation. As a consequence the operation will cost more than it would if the best machine in the plant were available.

Unit figures for the cost of each operation on each machine likely to be scheduled for it are available in the planning department. The actual cost of the operation on the less efficient machine that is doing the job is shown on the report. There is shown also the loss due to the use of the inefficient machine. The total of losses by operations is the total cost of inefficient machinery on the particular bearing concerned and represents an actual dollars-and-cents item that must be

SIZE — WEEKLY SUMMARY OF OPERATION AND INSPECTION

Operation Number	Quantity Finished	Scrap Due To				Work To Be Reoperated						Defective Work Passed	Pieces Paid For	Pieces Good	Time Used	Time Allowed	Per Cent Efficiency	Set-Up		Inefficient Method	Inefficient Machine	Waiting		Totals	
		This Operation	Value	Previous Operation	Value	Material	Value	Not Paid	Value	Paid	Value							Time	Amount			Time	Amount	Actual	Ideal

Weekly summary of operation and inspection

deducted from what would have been the final profit on the order had the most efficient equipment been available.

With figures like these to study the finance committee or the general manager can reach a sound conclusion as to whether or not an investment in additional machine equipment is justified. They can also decide just what savings would result from disposing of relatively inefficient or obsolete tools and replacing them with the best on the market. The cost of inefficient machinery, when worked out on this basis, is an item that commands respect.

Driving Box Liners

By CLIFFORD H. FRENCH

The methods of applying hub and pedestal liners to driving boxes vary on many roads. In the illustrations will be seen how this work is done on the Santa Fé system. Fig. 1 shows a pedestal liner which is of bronze and is cast into dovetail grooves that cross and form an X as in Fig. 2. The main dimensions are given.

In order to reduce the tendency of breakage in shoe and wedge flanges by the box bearing at the corners,

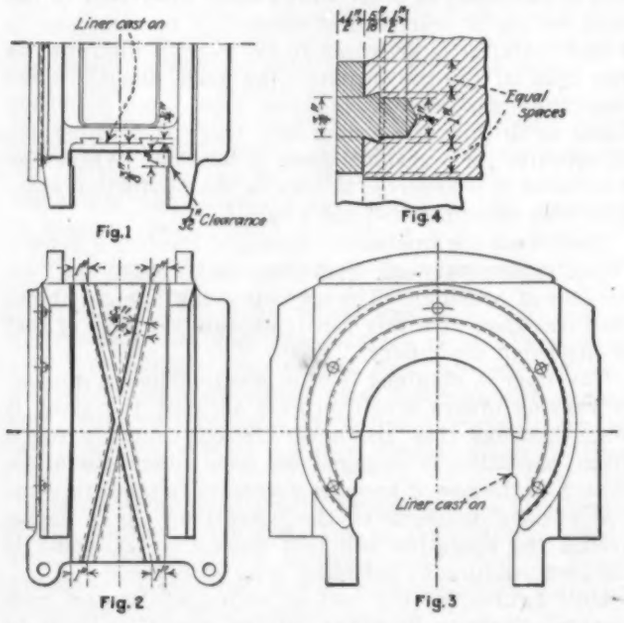


Fig. 1—Side clearance in flanges. Fig. 2—Crossed dovetail grooves. Fig. 3—Liner cast on driving box. Fig. 4—Details of dovetail and dowels

clearance grooves are planed, as in Fig. 1. The grooves are 1 in. wide in the sides of the driving-box flanges as shown and are $\frac{3}{16}$ in. deep. The dovetail grooves for the pedestal liner are $\frac{1}{4}$ in. deep.

Hub liners are cast in a circular but eccentric groove, as shown in Fig. 3. This groove, together with the five holes drilled in this box, effectually prevents the liner from turning. It will be noted in Fig. 4 that the dovetail groove is very much narrower than the face of the liner. This illustration shows the groove at the narrow ends where the corners of the dovetail are but little wider than the diameter of the cast dowel.

The dovetail at this point is but 1 in. wide while the stud or dowel holes are $\frac{3}{4}$ in. The dovetail is $\frac{3}{16}$ in. deep and the dowel holes $\frac{1}{2}$ in. below this. The liner is left $\frac{1}{2}$ in. thick.

Book Reviews

Graphic Statistics in Management. By William Henry Smith. 360 pages, 6x9 in. 242 illustrations. Published by McGraw-Hill Book Co., 370 Seventh Avenue, New York City. Price $4.

This volume is an attempt to treat the principles of statistical and graphical practice so as to show their relation and interdependence in such a way as to interest the business man and to enable him to use or to read this method of presenting data. With this in view the author has divided the volume into four parts: Statistics; Chart Construction; General Statistics and Graphic Application of Statistics.

The second part shows various methods of constructing charts of different kinds and illustrates pictorial pie and circle charts; bar charts; curve or line charts; ratio or logarithmic charts; the Z chart, map and flow charts. These are all illustrated and the student or business man should have no difficulty in finding a form of chart best suited to his needs. The book is carefully prepared and forms a fifth volume by the same author, on business practices.

Handbook of Canada. Published by the University of Toronto Press. Toronto. Four hundred and forty-nine pages, 7½x4¾ in. Fifty-four illustrations.

The growth of Canada is interestingly outlined and many illustrations show the country's wealth and resources. The subject is comprehensively treated and the various chapters dealing with the different phases of Canada were written by educators and historians of Canada. Many of the professors at the University of Toronto and many professors connected with the Dominion government are contributors.

The development of the chemical and metallurgical wealth of the country and the progress made by industries are shown as well as the agricultural and mineral expansions of Canada.

Engineering in American Industry. By Conrad Newton Lauer, Mem. A.S.M.E., Am. Acad. of Pol. & Soc. Science, Franklin Inst., N.E.L.A., Newcomen Soc. (London). 94 pages 9x12 in. Lavishly illustrated with charts and half-tone reproductions. Published by McGraw-Hill Book Co., Inc., New York. Price $2.50.

Mr. Lauer has rendered a real service in the collection of the information published in his book which is a reprint of the lecture he delivered at Princeton University under the Cyrus Fogg Bracket Foundation. Taking the case of a mythical American farmer of 1803 who needs a new plow he recounts the difficulties with transportation, communication, and manufacture encountered then, but which have now been swept away by the contributions of engineers to our industrial progress.

In vivid, graphic form is shown the marvelous development in railroads, in the power field, in industry during two generations. The story is a stimulating one.

The maps showing the industrial development of the United States at regular intervals from 1849 to the present are particularly interesting. These and many other charts and diagrams should be useful to manufacturers and advertisers who wish to show the connection between the development of their own product and that of industry as a whole.

Development of Machine Tools in New England

By Guy Hubbard

The concluding article — Difficulties in financing the Acme automatic screw machine — Formation of the National Acme Manufacturing Co.—Absorption of the Windsor Screw Machine Company

ALBERT W. HENN, whose portrait is shown in Fig. 163, was born at New Britain, Conn., in 1865. His school days came to an end in the grammar school, and at the age of thirteen he went to work in the Landers, Frary & Clark shop running a small brass-turning lathe. One year of this work undermined his health and so he obtained a position as a grocer's clerk, which position he held for two years. After this he returned to the factory, where he put in three years in the shipping department.

At the end of this time Mr. Henn, who was then nineteen, decided to see something of the world, so he "struck out" for Cleveland. There he spent $150 of his entire savings of $200 upon a course in commercial bookkeeping. Mr. Henn was bookkeeper for Levy & Stearn for thirteen years. It was during the last three years of his work with this concern that he became interested in his brother Edwin's invention, and during these three years he put every dollar that he could spare into this project.

After E. C. Henn returned from Cleveland, three more "Acmes" were built by using the original as a model—there being no working drawings. A customer was found for one of these machines in A. Schrader, the tire valve manufacturer, but the other two and the original were kept to run and test on the manufacture of product in the company's own shop, thus initiating a policy ever since followed, and one which has always enabled the company to discover any weak points and to try out all improvements.

Fig. 163—Albert W. Henn

A plan of expansion was immediately launched by A. W. Henn, in both the manufacture of Acme automatics and screw machine products, which was, under the circumstances, an extremely bold one. Five weeks after his arrival in Hartford, he had the concern located upon the ground floor of a two-story building just off Sheldon Street on Vredendale Avenue where $100 per month was paid on a five-year lease of the entire building. The building is shown in Fig. 164. Mr. Henn then made a trip to Cleveland, interested his old employer Abraham Stearn in the proposition, and immediately succeeded in borrowing $5,000 for one year at 10 per cent interest, paid in advance. With this new capital available a lot of ten "Acmes" was put through at once.

As soon as the lot of ten "Acmes" was completed, early in May, 1898, A. W. Henn made another and very important visit to Cleveland. This time he succeeded in convincing W. D. B. Alexander, president of the National Screw & Tack Co., that it would be profitable for him to start the manufacture of standard set and capscrews by the use of Acme automatics in Cleveland, as Mr. Henn had great faith that Cleveland was rapidly becoming a great center of production of the middle west. Mr. Alexander was so thoroughly convinced that he

For the author's forthcoming book. All rights reserved.

gave a conditional order for twenty Acme automatics, the condition being that the Acme Machine Screw Co. should take some of its payment for the automatics in stock in the new enterprise.

This was for those days a very large order for automatic screw machines and so taxed the capacity of the little Hartford shop that by June 1, 1898, it was necessary to expand it by occupying the entire second floor and by building an addition, as a result of which a new lease for ten years at $200 a month, dating from Jan. 1, 1899, was entered into.

The National Manufacturing Company

Meanwhile, Mr. Alexander had organized at Cleveland a new concern called the National Manufacturing Co., primarily for the purpose of manufacturing standard screws on his Acmes, with specials only as a "filler." The initial equipment of this new concern was nine ⅜-in., six ½-in., three ¾-in. and two 1¼-in. machines, which were set up in a building called "The little red barn," near the present Stanton plant of The National Acme Company.

Since the National Manufacturing Co. and the Acme Machine Screw Co. were financially and otherwise about equally interested in each other, the situation was that practically one concern had a machinery and special products plant at Hartford, Conn., and a primary standard product plant at Cleveland, Ohio. Such a connection became actual in 1901, when arrangements were completed to combine the Acme Machine Screw Co. and the National Manufacturing Co. as The National Acme Manufacturing Co., with W. D. B. Alexander, president; O. S. Werntz, treasurer; A. W. Henn, secretary; and E. C. Henn, general superintendent.

Since A. W. Henn was still strong in his belief in Cleveland as the most desirable location from both a manufacturing and a financial standpoint, he succeeded in inducing the company to move its Hartford plant to Cleveland. The construction of a new building at 7500 Stanton Avenue was begun at once, where the products and the machinery plants might be combined in one. The removal from Hartford meant a financial loss on the lease of the Vredendale Ave. plant, upon which the company had to continue to pay rent for about seven and a half years.

Since Mr. Hakewessell, who had been vice-president of the Acme Machine Screw Co., did not care to leave Hartford, A. W. Henn negotiated the purchase of his entire holdings in the business for a group composed of those now primarily interested, for the sum of approximately $50,000. However, Mr. Hakewessell did not permanently lose his interest in the automatic screw machine business, for in 1906 he became associated with Christopher M. Spencer as the Universal Machine Screw Co., manufacturing the Universal five-spindle automatic, which was their joint production. This business was eventually sold to the Corbin Screw Corporation, and in 1912 the Universal was further developed by the eighty-year old Mr. Spencer into the present New Britain six-spindle automatic. Mr. Spencer was, up to the time of his death, in 1922, an active mechanical engineer with the New Britain Machine Company.

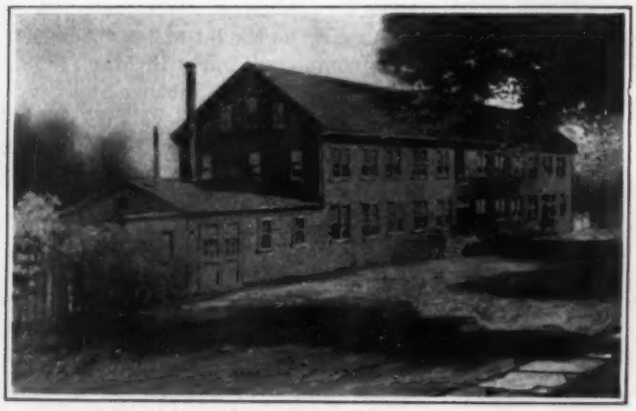


Fig. 164—Vredendale plant of the Acme Screw Machine Company, 1899

The wisdom of A. W. Henn's action in getting the business moved to Cleveland seems to have been amply proved by time, for from 1902 its growth has been constant. Five large additions to the original "Stanton" plant, shown in Fig. 165, were made necessary from time to time because of the increase in the business—and by 1915 The National Acme Manufacturing Co. had become one of the largest industries in Cleveland.

As has been mentioned in the previous chapter, the Gridley automatics, especially the multiple spindle, manufactured by the Windsor Machine Co., became, subsequent to 1910, very prominent in the automatic screw machine field.

Purchase of the Windsor Machine Company

In the summer of 1915, there was placed before The National Acme Manufacturing Co. the opportunity of purchasing the entire interests of the Windsor Machine Co. The price was $3,575,000 and the transfer took place in December, 1915. In less than a year after the transfer, the now greatly enlarged National Acme Manufacturing Co. was re-incorporated under the laws

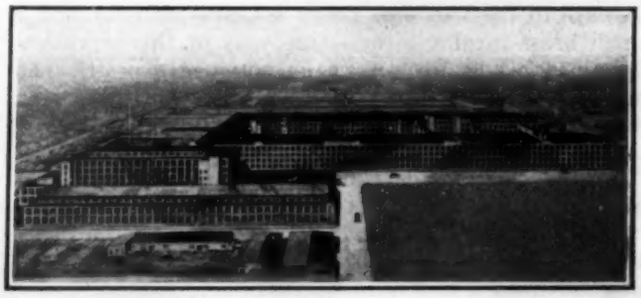


Fig. 165—Stanton plant of the National Acme Company

of the State of Ohio, its name being changed to The National Acme Co. The capitalization of the old concern had been $5,000,000 in common stock and $1,500,000 in preferred stock—the latter, however, having been retired on Dec. 1, previous to the amalgamation. Under a plan promulgated by Mr. Alexander the capitalization was increased to $25,000,000.

The mechanical situation remained practically unchanged—the manufacture of Acme automatics, auxiliary machines, taps, dies and screw-machine product being continued at Cleveland, while at Windsor, in addition to the continued manufacture of Gridley single and multiple-spindle machines, there was revived the manufacture of the semi-automatic piston and piston-ring machines which had been discontinued some five years before.

As soon as The National Acme Co. "got its bearings," it carried out plans already drawn up by the Windsor Machine Co. for doubling the size of the Windsor plant, and it tackled the housing situation there by buy-

ing and building upon an extensive scale. In spite of the increasing of the force to about 1,600 hands, which meant that this country town had in a short time grown in population from 2,500 to 5,000, the additional workers and their families were soon taken care of.

Expansion of the Cleveland Plant

The great war-time demand for Acme automatics also led to the expansion of the Cleveland plant on Stanton Avenue to the limit, and in 1915 it was decided to remove the products plant from that location, leaving the old factory entirely for the manufacture of machinery. A 15-acre tract of land was purchased on Coit Road and East 131st St., in the outskirts of Cleveland and a huge brick, steel and cement building mostly of one story was erected. This building, to be seen in the headpiece, covered 10½ acres of ground and was equipped with the most modern machinery for performing both first and subsequent operation work upon screw machine and upset products of both standard and

Fig. 166—Portion of the interior of the Coit plant

special sorts. There are today in the Coit plant about 2,500 machines, a few of which can be seen in Fig. 166, and it is the largest and best equipped screw-machine products plant in the world.

Before closing this series of articles it will be appropriate to tell of an experiment in housing that has been tried at Windsor by The National Acme Co. The company decided to tear down all the buildings upon the site of the old Robbins & Lawrence machine shops, and to erect thereon the largest apartment house in northern New England.

The building, shown in Fig. 167, fills more than the entire area once occupied by the Robbins & Lawrence machine shops on Mill Brook. It is a substantial structure of brick and concrete, and really consists of seventeen houses, each four stories in height and containing four five-room apartments. These houses appear as one huge building having seventeen fronts and four stories.

The apartments have steam heat, electricity for both lighting and cooking, hot water in unlimited quantities, and mechanical refrigeration—all being furnished from a central plant located in a separate building at the rear. With all these conveniences and comforts the apartments in the Namco Block, as it is called, rent for a figure so low as to fairly astonish a city apartment dweller.

[It is with sincere regret that since the publication of the previous article, we have been called upon to record the sudden death of E. C. Henn, inventor of the Acme multiple-spindle automatic.

Fig. 167—The "Namco" block, Windsor, Vermont

Mr. Henn was killed on Aug. 20 while driving his automobile across the Nickel Plate tracks near Painesville, Ohio, the automobile being struck by an express train.—Editor.]

The Centerless Method of Grinding

By George W. Binns
Cincinnati Milling Machine Co.

THE centerless grinder is a comparatively new development in the machine tool industry. This machine was first conceived as a single purpose tool, but on account of the extremely high productive features of the machine, it was tried out on a great variety of jobs. As the word implies, it is a machine for producing an accurately ground outside cylindrical surface with no apparent control of the center of rotation.

The principal elements of a modern centerless grinder are: A grinding-wheel, a regulating or feed-wheel and a work rest. The work rest may be provided with

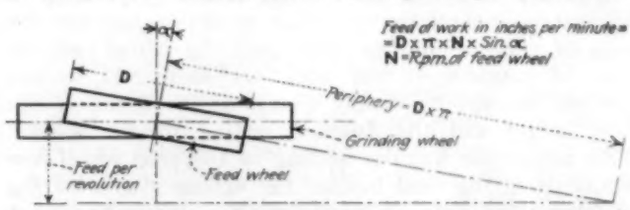

Feed of work in inches per minute =
= D x π x N x Sin. α
N = Rpm. of feed wheel
D
Periphery = D x π
Grinding wheel
Feed per revolution
Feed wheel

Fig. 1—Formula for figuring the traverse of the work

suitable guides leading the work in line with the wheels, and receiving it therefrom, and these elements may be arranged and combined in any of a number of different ways, the fundamental principle involved being the same in all. The grinding-wheel, due to the cutting pressure, forces the work against the work rest. It also forces it against the regulating or feed-wheel by the cutting pressure. The feed-wheel is generally of a material similar to the grinding wheel itself, which provides a surface sufficiently rough to prevent any slippage, causing the work to rotate at the same surface speed as the feed wheel itself. The

Extracts from address before the American Society of Mechanical Engineers, Cleveland, Ohio.

surface of the feed wheel can be quickly renewed by a simple truing operation.

Lateral movement of the work past the grinding wheel may also be imparted by the regulating or feed-wheel, when desired. It is accomplished by a relative tilt or angle between the feed-wheel spindle and the axis of the work, so that their centers do not fall in the same plane. In cases where the feed wheel has

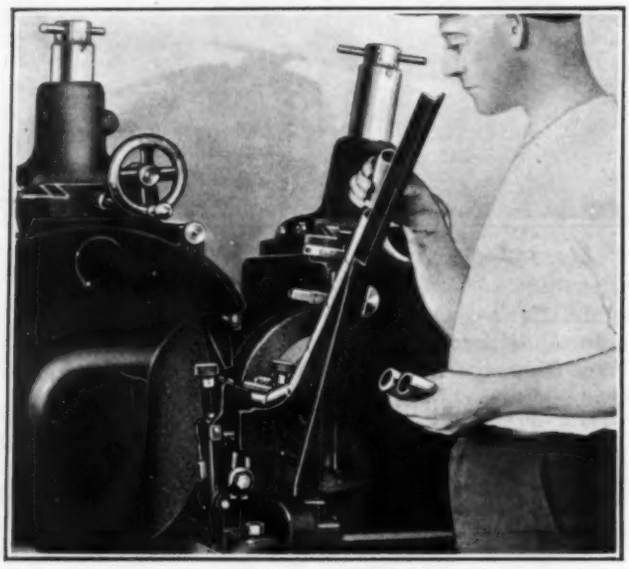


Fig. 2—Machine set for straight-through method of centerless grinding

face contact with the work, the same action is obtained by having the contact with the work at a point slightly below or above its center.

The traverse of the work through the machine can be figured by the formula given, the factors being shown in Fig. 1. The feed is theoretical and is based on the assumption that there is no slippage of the work in its contact with the feed-wheel. Actual results check very closely with this, the error being usually within 2 per cent.

The action of the feed wheel makes it possible to accurately control the grinding condition because the rate of traverse of the work past the wheel and the rate of rotation of the work are easily set to any desired amount by simply changing the speed of the feed wheel and the angular setting of its spindle. This adjustable angular setting of the feed wheel corresponds to the feed box on the ordinary grinder for changing the rate of work traverse, while the feed-wheel speed control corresponds to the feed box for changing the rate of rotation of the work head.

Faster Grinding on Centerless Machine

The actual requirement for economical grinding is very much the same on center and centerless machines. There are, however, several distinct differences in the machines, the principal one being as follows:

The centerless grinder is more productive because the grinding action is practically continuous. The actual rate of grinding is also faster because the work is supported more rigidly at the point of grinding, making it possible to use the grinding wheel to its limit. There is further gain due to the fact that it is not necessary to leave so much stock on the work which is to be ground, as the average job ground on the centerless grinder will clean up with one-half the stock required when grinding on centers. This is due to the fact that the centerless works to the nearest full diameter while center type machines work from a radius. This factor also permits of an effective saving on the wheel wear, and a further saving is secured since the centering operation is not necessary. The average gain on production when a job is taken from a center-type machine and put on a centerless is over threefold, varying from two to ten in extreme cases. Most users find it possible to obtain more uniformly accurate work by the centerless method, mainly because the moving elements in the machine for any given operation are reduced to the absolute minimum, and this also materially reduces the skill required of the operator.

Greater Accuracy—Less Scrap

On many jobs that have been transferred to the centerless, such as piston pins and similar work, the limits of accuracy specified have been materially reduced and at the same time there has been a large decrease in the percentage of scrap from the grinding operation. These results are sufficient to justify considerable effort in making the work adaptable to centerless machines. Many of the most successful installations of centerless grinding today are on jobs that a few months ago were considered impossible.

There are two popular methods of centerless grinding, both using the same basic principle. The first and most popular is commonly called the "straight through" method and is applicable to all straight cylindrical work, such as piston pins and straight rolls. Fig. 2 shows a machine properly set for this class of work. The second method is commonly called "shoulder" grinding, and the operation is somewhat different. In this

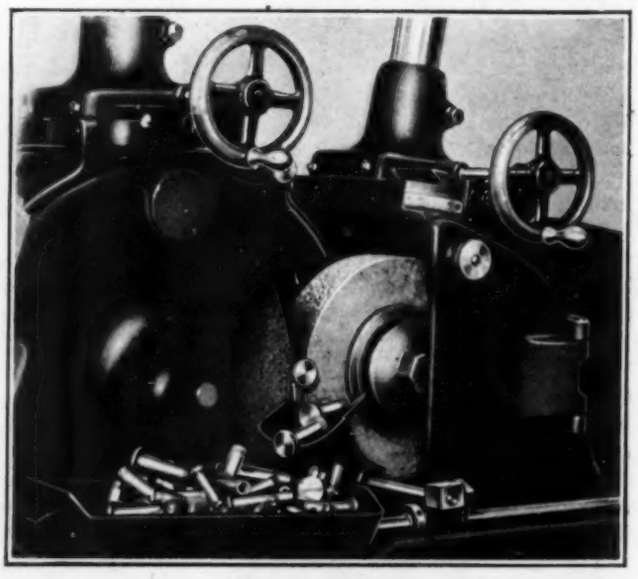


Fig. 3—Machine set for shoulder method of centerless grinding

method, illustrated in Fig. 3, the work is placed between the wheels to an end stop, the wheels are then closed in to a set stop, thereby sizing the work, and as the wheels are released to the original position the work is ejected.

This method broadens the field of centerless grinding so as to include many kinds of work which were formerly not considered suitable for these machines.

American Standard Screw Threads—III

The fine-thread series of screw threads for use with medium-fit and close-fit tolerances. Its use is also permissible in producing Class III tolerances

THE American Standard Fine-Thread Series, defined in Table 14, is recommended for use with Medium Fit (Class 3) tolerances and Close Fit (Class 4) tolerances. Its use with Free Fit (Class 2) tolerances is also permissible, especially in producing (Class 3) tolerances, as described under "Classification of Fits," Sec. 2.

The resulting dimensions of external and internal screw threads with these fits and tolerances are shown in Tables 15, 16, 17, 18, 19, 20 and 21.

Appendixes

Appendix A

DERIVATION OF TOLERANCES

Net Pitch Diameter Tolerance. The net pitch diameter tolerances for the several classes or grades are based on selections from a tolerance series for a pitch of in., increasing by increments of 0.0005 in. as follows:

Grade	Tolerance	Grade	Tolerance
A	0.0005	F	0.0030
B	0.0010	G	0.0035
C	0.0015	H	0.0040
D	0.0020	I	0.0045
E	0.0025	J	0.0050

The Grades Selected are:

For loose fit.....I	For medium fit...D
For free fit.....F	For close fit.....B

Pitch diameter tolerances for pitches finer than $\frac{1}{20}$ in. are to each other and to the tolerance for $\frac{1}{20}$ in. as the 0.6th power of their respective pitches.

Pitch diameter tolerances for pitches coarser than $\frac{1}{20}$ in. are to each other and to the tolerance for $\frac{1}{20}$ in. as the 0.9th power of their respective pitches.

The factor 0.6 was chosen for pitches finer than $\frac{1}{20}$ in. because resulting tolerances except in two instances do not vary more than 0.0001 in. from the pitch diameter tolerance in the A.S.M.E. Machine Screw Standard.

Table 14 Fine-Thread Series—General Dimensions[1]

1	2	3	4	5	6	7
Identification		Basic Diameters			Thread Data	
Sizes	Threads per Inch (n)	Major Diameter (D) (Inches)	Pitch Diameter (E) (Inches)	Minor Diameter (K) (Inches)	Pitch[2] (p) (Inches)	Basic Depth of Thread (h) (Inches)
0	80	0.0600	0.0519	0.0438	0.0125000	0.00812
1	72	0.0730	0.0640	0.0550	0.0138889	0.00902
2	64	0.0860	0.0759	0.0657	0.0156250	0.01014
3	56	0.0990	0.0874	0.0758	0.0178571	0.01160
4	48	0.1120	0.0985	0.0849	0.0208333	0.01353
5	44	0.1250	0.1102	0.0955	0.0227273	0.01476
6	40	0.1380	0.1218	0.1055	0.0250000	0.01624
8	36	0.1640	0.1460	0.1279	0.0277778	0.01804
10	32	0.1900	0.1697	0.1494	0.0312500	0.02030
12	28	0.2160	0.1928	0.1696	0.0357143	0.02319
1/4	28	0.2500	0.2268	0.2036	0.0357143	0.02319
5/16	24	0.3125	0.2854	0.2584	0.0416667	0.02706
3/8	24	0.3750	0.3479	0.3209	0.0416667	0.02706
7/16	20	0.4375	0.4050	0.3725	0.0500000	0.03248
1/2	20	0.5000	0.4675	0.4350	0.0500000	0.03248
9/16	18	0.5625	0.5264	0.4903	0.0555556	0.03608
5/8	18	0.6250	0.5889	0.5528	0.0555556	0.03608
3/4	16	0.7500	0.7094	0.6688	0.0625000	0.04060
7/8	14	0.8750	0.8286	0.7822	0.0714286	0.04640
1	14	1.0000	0.9536	0.9072	0.0714286	0.04640
1 1/8	12	1.1250	1.0709	1.0167	0.0833333	0.05413
1 1/4	12	1.2500	1.1959	1.1417	0.0833333	0.05413
1 3/8	12	1.5000	1.4459	1.3917	0.0833333	0.05413

[1] The dimensions of screw-thread gages and other important information on the gaging of screw threads will be found in the second report of this Committee entitled "Gages and Gaging of Screw Threads."

[2] This column is given to seven decimal places for computation purposes only (

Extreme Pitch Diameter Tolerance. To obtain the extreme pitch diameter tolerance there is added to the net tolerance a "gage increment" obtained as follows:

To secure extreme tolerances, add to net tolerances:
- Diameter tolerance—"Go" gage
- Diametrical equivalent of lead tolerance—"Go" gage
- Diametrical equivalent of angle tolerance—"Go" gage
- Diameter tolerance—"NOT GO" gage,

then subtract the following:
- Diametrical equivalent of angle tolerance—"NOT GO" gage,
- ½ Diametrical equivalent of lead tolerance—"NOT GO" gage.

For instance, using the tolerances (as set by the National Screw Thread Commission) for a 20-pitch gage, according to this rule the net tolerance would be increased by:

Diameter tolerance—"GO," inches.....	0.0002
Equivalent lead tolerance—"GO," inches.....	0.00034
Equivalent angle tolerance—"GO," inches.....	0.0002
Diameter tolerance—"NOT GO," inches.....	0.0002
Total, inches	0.00094

and would be decreased by:

Equivalent angle tolerance—"NOT GO," inches	0.0002
½ lead tolerance—"NOT GO," inches.....	0.00017
Total inches	0.00037

Total increase, 0.00094 − 0.00037 = 0.00057 inches.

Since the resulting extreme tolerances determine the actual allowable limits of the work itself, these only are given in the preceding tables. The actual net tolerances obtained will depend on the method of gaging used. (See report on "Gages and Gaging of Screw Threads.")

Appendix B

RELATION OF LEAD AND ANGLE ERRORS TO PITCH DIAMETER TOLERANCES

Effect of Lead Error on Pitch Diameter Tolerance. The tolerances specified for pitch diameters include all errors of pitch and angle. Column 4 of Tables 2, 3, 4 and 5 gives the amount of lead error which absorbs one-half of specified pitch diameter tolerance. Lead error × 1.732 = equivalent pitch diameter error.

Effect of Angle Error on Pitch Diameter Tolerance. Column 5 of the above-mentioned tables gives the variation in the half angle of thread which absorbs one-half of the specified pitch diameter tolerance.

The formula giving the relation between the amount

Table 15 Fine-Thread Series—Loose Fit (Class 1)—Nuts[1]

1	2	3	6	7	8	9	10	11
			Pitch Diameter			Minor Diameter		
Size	Threads per Inch	Minimum,[2] Major Diameter[3] (Inches)	Minimum[3] (Inches)	Tolerance[4] (Inches)	Maximum (Inches)	Minimum (Inches)	Tolerance (Inches)	Maximum (Inches)
0	80	0.060	0.0519	0.0024	0.0543	0.0465	0.0013	0.0478
1	72	0.073	0.0640	0.0025	0.0665	0.0580	0.0015	0.0595
2	64	0.086	0.0759	0.0026	0.0785	0.0691	0.0017	0.0708
3	56	0.099	0.0874	0.0028	0.0902	0.0797	0.0019	0.0816
4	48	0.112	0.0985	0.0031	0.1016	0.0894	0.0023	0.0917
5	44	0.125	0.1102	0.0032	0.1134	0.1004	0.0025	0.1029
6	40	0.138	0.1218	0.0034	0.1252	0.1109	0.0027	0.1136
8	36	0.164	0.1460	0.0036	0.1496	0.1339	0.0030	0.1369
10	32	0.190	0.1697	0.0038	0.1735	0.1562	0.0034	0.1596
12	28	0.216	0.1928	0.0043	0.1971	0.1773	0.0039	0.1812

[1] This fit is recommended for nuts only, in the numbered sizes.
[2] Basic diameter.
[3] Dimensions given are allowable only with tap having theoretically sharp corners. Threaded hole must not reject correct basic "Go" gage by interference with rounded roots due to worn tap. Minimum flat at root equals $\frac{1}{16} \times p$.
[4] The tolerances specified for pitch diameter are cumulative and also include errors of lead and angle.

Table 16 Fine-Thread Series—Free Fit (Class 2)—Screws

1	2	3	4	5	6	7	8	9
		Major Diameter			Pitch Diameter			
Sizes	Threads per Inch	Maximum[1] (Inches)	Tolerance (Inches)	Minimum (Inches)	Maximum[1] (Inches)	Tolerance[2] (Inches)	Minimum (Inches)	Maximum[3] Minor Diameter (Inches)
0	80	0.060	0.0034	0.0566	0.0519	0.0017	0.0502	0.0447
1	72	0.073	0.0036	0.0694	0.0640	0.0018	0.0622	0.0560
2	64	0.086	0.0038	0.0822	0.0759	0.0019	0.0740	0.0668
3	56	0.099	0.0040	0.0950	0.0874	0.0020	0.0854	0.0771
4	48	0.112	0.0044	0.1076	0.0985	0.0022	0.0963	0.0864
5	44	0.125	0.0046	0.1204	0.1102	0.0023	0.1079	0.0971
6	40	0.138	0.0048	0.1332	0.1218	0.0024	0.1194	0.1073
8	36	0.164	0.0050	0.1590	0.1460	0.0025	0.1435	0.1299
10	32	0.190	0.0054	0.1846	0.1697	0.0027	0.1670	0.1517
12	28	0.216	0.0062	0.2098	0.1928	0.0031	0.1897	0.1722
1/4	28	0.2500	0.0062	0.2438	0.2268	0.0031	0.2237	0.2062
5/16	24	0.3125	0.0066	0.3059	0.2854	0.0033	0.2821	0.2614
3/8	24	0.3750	0.0066	0.3684	0.3479	0.0033	0.3446	0.3239
7/16	20	0.4375	0.0072	0.4303	0.4050	0.0036	0.4014	0.3762
1/2	20	0.5000	0.0072	0.4928	0.4675	0.0036	0.4639	0.4387
9/16	18	0.5625	0.0082	0.5543	0.5264	0.0041	0.5223	0.4943
5/8	18	0.6250	0.0082	0.6168	0.5889	0.0041	0.5848	0.5568
3/4	16	0.7500	0.0090	0.7410	0.7094	0.0045	0.7049	0.6733
7/8	14	0.8750	0.0098	0.8652	0.8386	0.0049	0.8337	0.7874
1	14	1.0000	0.0098	0.9902	0.9536	0.0049	0.9487	0.9124
1 1/8	12	1.1250	0.0112	1.1138	1.0709	0.0056	1.0653	1.0228
1 1/4	12	1.2500	0.0113	1.2388	1.1959	0.0056	1.1903	1.1478
1 1/8	12	1.5000	0.0112	1.4888	1.4459	0.0056	1.4403	1.3978

[1] Basic diameter.
[2] Dimensions given are figured to the intersection of the worn tool are with a center line through crest and root. Minimum flat at root equals $\frac{1}{16} \times p$.
[3] The tolerances specified for pitch diameter are cumulative and also include errors of lead and angle.

Table 17 Fine-Thread Series—Free Fit (Class 2)—Nuts

1	2	3	6	7	8	9	10	11
			Pitch Diameter			Minor Diameter		
Size	Threads per Inch	Minimum[1] Major Diameter[2] (Inches)	Minimum[1] (Inches)	Tolerance[3] (Inches)	Maximum (Inches)	Minimum (Inches)	Tolerance (Inches)	Maximum (Inches)
0	80	0.0600	0.0519	0.0017	0.0536	0.0465	0.0013	0.0478
1	72	0.0730	0.0640	0.0018	0.0658	0.0580	0.0015	0.0595
2	64	0.0860	0.0759	0.0019	0.0778	0.0691	0.0017	0.0708
3	56	0.0990	0.0874	0.0020	0.0894	0.0797	0.0019	0.0816
4	48	0.1120	0.0985	0.0022	0.1007	0.0894	0.0023	0.0917
5	44	0.1250	0.1102	0.0023	0.1125	0.1004	0.0025	0.1029
6	40	0.1380	0.1218	0.0024	0.1242	0.1109	0.0027	0.1136
8	36	0.1640	0.1460	0.0025	0.1485	0.1339	0.0030	0.1369
10	32	0.1900	0.1697	0.0027	0.1724	0.1562	0.0034	0.1596
12	28	0.2160	0.1928	0.0031	0.1959	0.1773	0.0039	0.1812
1/4	28	0.2500	0.2268	0.0031	0.2299	0.2113	0.0039	0.2152
5/16	24	0.3125	0.2854	0.0033	0.2887	0.2674	0.0045	0.2719
3/8	24	0.3750	0.3479	0.0033	0.3512	0.3299	0.0045	0.3344
7/16	20	0.4375	0.4050	0.0036	0.4086	0.3834	0.0054	0.3888
1/2	20	0.5000	0.4675	0.0036	0.4711	0.4459	0.0054	0.4513
9/16	18	0.5625	0.5264	0.0041	0.5305	0.5024	0.0060	0.5084
5/8	18	0.6250	0.5889	0.0041	0.5930	0.5649	0.0060	0.5709
3/4	16	0.7500	0.7094	0.0045	0.7139	0.6823	0.0068	0.6891
7/8	14	0.8750	0.8286	0.0049	0.8335	0.7977	0.0077	0.8054
1	14	1.0000	0.9536	0.0049	0.9585	0.9227	0.0077	0.9304
1 1/8	12	1.1250	1.0709	0.0056	1.0765	1.0348	0.0090	1.0438
1 1/4	12	1.2500	1.1959	0.0056	1.2015	1.1598	0.0090	1.1688
1 1/8	12	1.5000	1.4459	0.0056	1.4515	1 4098	0.0090	1.4188

[1] Basic diameter.
[2] Dimensions given are allowable only with tap having theoretically sharp corners. Threaded hole must not reject correct basic "Go" gage by interference with rounded roots due to worn tap. Minimum flat at root equals $\frac{1}{16} \times p$.
[3] The tolerances specified for pitch diameter are cumulative and also include errors of lead and angle.

Table 18 Fine-Thread Series—Medium Fit (Class 3)—Screws

1	2	3	4	5	6	7	8	9
		Major Diameter			Pitch Diameter			
Size	Threads per Inch	Maximum[1] (Inches)	Tolerance (Inches)	Minimum (Inches)	Maximum[1] (Inches)	Tolerance[2] (Inches)	Minimum (Inches)	Maximum[3] Minor Diameter (Inches)
0	80	0.0600	0.0034	0.0566	0.0519	0.0013	0.0506	0.0447
1	72	0.0730	0.0036	0.0694	0.0640	0.0013	0.0627	0.0560
2	64	0.0860	0.0038	0.0822	0.0759	0.0014	0.0745	0.0668
3	56	0.0990	0.0040	0.0950	0.0874	0.0015	0.0859	0.0771
4	48	0.1120	0.0044	0.1076	0.0985	0.0016	0.0969	0.0864
5	44	0.1250	0.0046	0.1204	0.1102	0.0016	0.1086	0.0971
6	40	0.1380	0.0048	0.1332	0.1218	0.0017	0.1201	0.1073
8	36	0.1640	0.0050	0.1590	0.1460	0.0018	0.1443	0.1299
10	32	0.1900	0.0054	0.1846	0.1697	0.0019	0.1678	0.1517
12	28	0.2160	0.0062	0.2098	0.1928	0.0022	0.1906	0.1722
1/4	28	0.2500	0.0062	0.2438	0.2268	0.0022	0.2246	0.2062
5/16	24	0.3125	0.0066	0.3059	0.2854	0.0024	0.2830	0.2614
3/8	24	0.3750	0.0066	0.3684	0.3479	0.0024	0.3455	0.3239
7/16	20	0.4375	0.0072	0.4303	0.4050	0.0026	0.4024	0.3762
1/2	20	0.5000	0.0072	0.4928	0.4675	0.0026	0.4649	0.4387
9/16	18	0.5625	0.0082	0.5543	0.5264	0.0030	0.5234	0.4943
5/8	18	0.6250	0.0082	0.6168	0.5889	0.0030	0.5859	0.5568
3/4	16	0.7500	0.0090	0.7410	0.7094	0.0032	0.7062	0.6733
7/8	14	0.8750	0.0098	0.8652	0.8286	0.0036	0.8250	0.7874
1	14	1.0000	0.0098	0.9902	0.9536	0.0036	0.9500	0.9124
1 1/8	12	1.1250	0.0112	1.1138	1.0709	0.0040	1.0669	1.0228
1 1/4	12	1.2500	0.0112	1.2388	1.1959	0.0040	1.1919	1.1478
1 1/8	12	1.5000	0.0112	1.4888	1.4459	0.0040	1.4419	1.3978

[1] Basic diameter.
[2] Dimensions given are figured to the intersection of the worn tool are with a center line through crest and root. Minimum flat at root equals $\frac{1}{16} \times p$.
[3] The tolerances specified for pitch diameter are cumulative and also include errors of lead and angle.

Table 19 Fine-Thread Series—Medium Fit (Class 3)—Nuts

1	2	3	6	7	8	9	10	11
			Pitch Diameter			Minor Diameter		
Size	Threads per Inch	Minimum[1] Major Diameter[2] (Inches)	Minimum[1] (Inches)	Tolerance[3] (Inches)	Maximum (Inches)	Minimum (Inches)	Tolerance (Inches)	Maximum (Inches)
0	80	0.0600	0.0519	0.0013	0.0532	0.0465	0.0013	0.0478
1	72	0.0730	0.0640	0.0013	0.0653	0.0580	0.0015	0.0595
2	64	0.0860	0.0759	0.0014	0.0773	0.0691	0.0017	0.0708
3	56	0.0990	0.0874	0.0015	0.0889	0.0797	0.0019	0.0816
4	48	0.1120	0.0985	0.0016	0.1001	0.0894	0.0023	0.0917
5	44	0.1250	0.1102	0.0016	0.1118	0.1004	0.0025	0.1029
6	40	0.1380	0.1218	0.0017	0.1235	0.1109	0.0027	0.1136
8	36	0.1640	0.1460	0.0018	0.1478	0.1339	0.0030	0.1369
10	32	0.1900	0.1697	0.0019	0.1716	0.1562	0.0034	0.1596
12	28	0.2160	0.1928	0.0022	0.1950	0.1773	0.0039	0.1812
1/4	28	0.2500	0.2268	0.0022	0.2290	0.2113	0.0039	0.2152
5/16	24	0.3125	0.2854	0.0024	0.2878	0.2674	0.0045	0.2719
3/8	24	0.3750	0.3479	0.0024	0.3503	0.3299	0.0045	0.3344
7/16	20	0.4375	0.4050	0.0026	0.4076	0.3834	0.0054	0.3888
1/2	20	0.5000	0.4675	0.0026	0.4701	0.4459	0.0054	0.4513
9/16	18	0.5625	0.5264	0.0030	0.5294	0.5024	0.0060	0.5084
5/8	18	0.6250	0.5889	0.0030	0.5919	0.5649	0.0060	0.5709
3/4	16	0.7500	0.7094	0.0032	0.7126	0.6823	0.0068	0.6891
7/8	14	0.8750	0.8286	0.0036	0.8322	0.7977	0.0077	0.8054
1	14	1.0000	0.9536	0.0036	0.9572	0.9227	0.0077	0.9304
1 1/8	12	1.1250	1.0709	0.0040	1.0749	1.0348	0.0090	1.0438
1 1/4	12	1.2500	1.1959	0.0040	1.1999	1.1598	0.0090	1.1688
1 1/8	12	1.5000	1.4459	0.0040	1.4499	1.4098	0.0090	1.4188

[1] Basic diameter.
[2] Dimensions given are allowable only with tap having theoretically sharp corners. Threaded hole must not reject correct basic "Go" gage by interference with rounded roots due to worn tap. Minimum flat at root equals $\frac{1}{16} \times p$.
[3] The tolerances specified for pitch diameter are cumulative and also include errors of lead and angle.

Table 20 Fine-Thread Series—Close Fit (Class 4)—Screws

1	2	3	4	5	6	7	8	9
		Major Diameter			Pitch Diameter			
Size	Threads per Inch	Maximum[1] (Inches)	Tolerance (Inches)	Minimum (Inches)	Maximum (Inches)	Tolerance[2] (Inches)	Minimum (Inches)	Maximum[3] Minor Diameter (Inches)
0	80	0.0600	0.0034	0.0566	0.0520	0.0006	0.0514	0.0447
1	72	0.0730	0.0036	0.0694	0.0641	0.0007	0.0634	0.0560
2	64	0.0860	0.0038	0.0822	0.0760	0.0007	0.0753	0.0668
3	56	0.0990	0.0040	0.0950	0.0876	0.0007	0.0869	0.0771
4	48	0.1120	0.0044	0.1076	0.0987	0.0008	0.0979	0.0864
5	44	0.1250	0.0046	0.1204	0.1104	0.0009	0.1096	0.0971
6	40	0.1380	0.0048	0.1332	0.1220	0.0009	0.1211	0.1073
8	36	0.1640	0.0050	0.1590	0.1462	0.0009	0.1453	0.1299
10	32	0.1900	0.0054	0.1846	0.1699	0.0010	0.1689	0.1517
12	28	0.2160	0.0062	0.2098	0.1930	0.0011	0.1919	0.1722
1/4	28	0.2500	0.0062	0.2438	0.2270	0.0011	0.2259	0.2062
5/16	24	0.3125	0.0066	0.3059	0.2857	0.0012	0.2845	0.2614
3/8	24	0.3750	0.0066	0.3684	0.3482	0.0012	0.3470	0.3239
7/16	20	0.4375	0.0072	0.4303	0.4053	0.0013	0.4040	0.3762
1/2	20	0.5000	0.0072	0.4928	0.4678	0.0013	0.4665	0.4387
9/16	18	0.5625	0.0082	0.5543	0.5267	0.0015	0.5252	0.4943
5/8	18	0.6250	0.0082	0.6168	0.5892	0.0015	0.5877	0.5568
3/4	16	0.7500	0.0090	0.7410	0.7098	0.0016	0.7082	0.6733
7/8	14	0.8750	0.0098	0.8652	0.8290	0.0018	0.8272	0.7874
1	14	1.0000	0.0098	0.9902	0.9540	0.0018	0.9522	0.9124
1 1/8	12	1.1250	0.0112	1.1138	1.0714	0.0020	1 0694	1.0228
1 1/4	12	1.2500	0.0112	1.2388	1.1964	0.0020	1 1944	1.1478
1 1/8	12	1.5000	0.0112	1.4888	1 4464	0.0020	1 4444	1.3978

[1] Basic diameter.
[2] Dimensions given are figured to the intersection of the worn tool are with a centerline through crest and root. Minimum flat at root equals $\frac{1}{8} \times p$.
[3] The tolerances specified for pitch diameter are cumulative and also include errors of lead and angle.

Table 21 Fine-Thread Series—Close Fit (Class 4) —Nuts

1	2	3	6	7	8	9	10	11
Size	Threads per Inch	Minimum[1] Major Diameter[2] (Inches)	Pitch Diameter			Minor Diameter		
			Minimum[1] (Inches)	Tolerance[3] (Inches)	Maximum (Inches)	Minimum (Inches)	Tolerance (Inches)	Maximum (Inches)
1/4	28	0.2500	0.2268	0.0011	0.2279	0.2113	0.0039	0.2152
5/16	24	0.3125	0.2854	0.0012	0.2866	0.2674	0.0045	0.2719
3/8	24	0.3750	0.3479	0.0012	0.3491	0.3299	0.0045	0.3344
7/16	20	0.4375	0.4050	0.0013	0.4063	0.3834	0.0054	0.3888
1/2	20	0.5000	0.4675	0.0013	0.4688	0.4459	0.0054	0.4513
9/16	18	0.5625	0.5264	0.0015	0.5279	0.5024	0.0060	0.5084
5/8	18	0.6250	0.5889	0.0015	0.5904	0.5649	0.0060	0.5709
3/4	16	0.7500	0.7094	0.0016	0.7110	0.6823	0.0068	0.6891
7/8	14	0.8750	0.8286	0.0018	0.8304	0.7977	0.0077	0.8054
1	14	1.0000	0.9536	0.0018	0.9554	0.9237	0.0077	0.9304
1 1/8	12	1.1250	1.0709	0.0020	1.0729	1.0348	0.0090	1.0438
1 1/4	12	1.2500	1.1959	0.0020	1.1979	1.1598	0.0090	1.1688
1 1/8	12	1.5000	1.4459	0.0020	1.4479	1.4098	0.0090	1.4188

[1] Basic diameter

[2] Dimensions given are allowable only with tap having theoretically sharp corners. Threaded hole must not reject correct basic "Go" gage by interference with rounded roots due to worn tap. Minimum flat at root equals $1/24 \times p$.

[3] The tolerances specified for pitch diameter are cumulative and also include errors of lead and angle.

Table 22 Coarse-Thread Series—Loose Fit (Class 1)—Screws

1	2	3	4	5	6	7	8
Size	Threads per Inch	Major Diameter			Pitch Diameter[1]		Maximum Minor Diameter[2] (Inches)
		Maximum (Inches)	Tolerance (Inches)	Minimum (Inches)	Maximum (Inches)	Minimum (Inches)	
1	64	0.0723	0.0052	0.0671	0.0622	0.0596	0.0531
2	56	0.0852	0.0056	0.0796	0.0736	0.0708	0.0633
3	48	0.0981	0.0062	0.0919	0.0848	0.0815	0.0725
4	40	0.1110	0.0068	0.1043	0.0948	0.0914	0.0803
5	40	0.1240	0.0068	0.1172	0.1078	0.1044	0.0933
6	32	0.1380	0.0076	0.1293	0.1166	0.1128	0.0996
8	32	0.1639	0.0076	0.1553	0.1426	0.1388	0.1245
10	24	0.1887	0.0092	0.1795	0.1616	0.1570	0.1376
12	24	0.2147	0.0092	0.2055	0.1876	0.1830	0.1636
1/4	20	0.2485	0.0102	0.2383	0.2160	0.2109	0.1872
5/16	18	0.3109	0.0114	0.2995	0.2743	0.2691	0.2437
3/8	16	0.3732	0.0126	0.3606	0.3336	0.3263	0.2965
7/16	14	0.4354	0.0140	0.4214	0.3860	0.3820	0.3478
1/2	13	0.4978	0.0148	0.4830	0.4478	0.4404	0.4034
9/16	12	0.5601	0.0158	0.5443	0.5060	0.4981	0.4579
5/8	11	0.6234	0.0170	0.6064	0.5634	0.5549	0.5109
3/4	10	0.7472	0.0184	0.7288	0.6922	0.6720	0.6245
7/8	9	0.8719	0.0200	0.8519	0.7997	0.7897	0.7356
1	8	0.9966	0.0222	0.9744	0.9154	0.9043	0.8432
1 1/8	7	1.1211	0.0248	1.0963	1.0283	1.0159	0.9458
1 1/4	7	1.2461	0.0248	1.2213	1.1533	1.1409	1.0708
1 1/8	6	1.4956	0.0290	1.4666	1.3873	1.3728	1.2911
1 3/4	5	1.7448	0.0338	1.7110	1.6140	1.5980	1.4904
2	4 1/2	1.9943	0.0368	1.9575	1.8500	1.8318	1.7217
2 1/4	4 1/2	2.2443	0.0368	2.2075	2.1000	2.0816	1.9717
2 1/2	4	2.4936	0.0408	2.4528	2.3312	2.3108	2.1899
2 3/4	4	2.7436	0.0408	2.7028	2.5812	2.5608	2.4399
3	4	2.9936	0.0408	2.9528	2.8312	2.8108	2.6899

[1] The tolerances specified for pitch diameter are cumulative and also include errors of lead and angle.

[2] Dimensions given are figured to the intersection of the worn tool are with a centerline through crest and root. Minimum flat at root equal $1/8 \times p$.

Table 24 Fine-Thread Series—Loose Fit (Class 1) —Screws

1	2	3	4	5	6	7
Size	Threads per Inch	Major Diameter		Pitch Diameter[1]		Maximum Minor[2] Diameter (Inches)
		Maximum (Inches)	Minimum (Inches)	Maximum (Inches)	Minimum (Inches)	
0	80	0.0593	0.0545	0.0512	0.0488	0.0440
1	72	0.0723	0.0673	0.0633	0.0608	0.0553
2	64	0.0853	0.0801	0.0752	0.0726	0.0661
3	56	0.0982	0.0926	0.0866	0.0838	0.0763
4	48	0.1111	0.1049	0.0976	0.0945	0.0855
5	44	0.1241	0.1177	0.1093	0.1061	0.0962
6	40	0.1370	0.1302	0.1208	0.1174	0.1063
8	36	0.1629	0.1557	0.1449	0.1413	0.1288
10	32	0.1889	0.1813	0.1686	0.1648	0.1506
12	28	0.2148	0.2062	0.1916	0.1873	0.1710
1/4	28	0.2488	0.2402	0.2256	0.2213	0.2050
5/16	24	0.3112	0.3020	0.2841	0.2795	0.2601
3/8	24	0.3737	0.3645	0.3466	0.3420	0.3226
7/16	20	0.4360	0.4258	0.4035	0.3984	0.3747
1/2	20	0.4985	0.4883	0.4660	0.4609	0.4372
9/16	18	0.5609	0.5495	0.5248	0.5191	0.4927
5/8	18	0.6234	0.6120	0.5873	0.5816	0.5552
3/4	16	0.7482	0.7356	0.7076	0.7013	0.6715
7/8	14	0.8729	0.8589	0.8265	0.8195	0.7853
1	14	0.9979	0.9839	0.9515	0.9445	0.9103
1 1/8	12	1.1226	1.1068	1.0685	1.0606	1.0204
1 1/4	12	1.2476	1.2318	1.1935	1.1856	1.1454
1 3/8	12	1.4976	1.4818	1.4435	1.4356	1.3954

[1] The tolerances specified for pitch diameter are cumulative and also include errors of lead and angle.

[2] Dimensions given are figured to the intersection of the worn tool are with a centerline through crest and root. Minimum flat at root equals $1/8 \times p$.

Table 23 Coarse-Thread Series, Loose Fit (Class 1) —Nuts

1	2	3	4	5	6	7
Size	Threads per Inch	Minimum Major[1] Diameter[2] (Inches)	Pitch Diameter[3]		Minor Diameter	
			Minimum (Inches)	Maximum (Inches)	Minimum (Inches)	Maximum (Inches)
1	64	0.0730	0.0629	0.0655	0.0561	0.0578
2	56	0.0860	0.0744	0.0772	0.0667	0.0686
3	48	0.0990	0.0855	0.0886	0.0764	0.0787
4	40	0.1120	0.0958	0.0992	0.0849	0.0876
5	40	0.1250	0.1088	0.1122	0.0979	0.1006
6	32	0.1380	0.1177	0.1215	0.1042	0.1076
8	32	0.1640	0.1437	0.1475	0.1302	0.1336
10	24	0.1900	0.1629	0.1675	0.1449	0.1494
12	24	0.2160	0.1889	0.1935	0.1709	0.1754
1/4	20	0.2500	0.2175	0.2226	0.1959	0.2013
5/16	18	0.3125	0.2764	0.2821	0.2524	0.2584
3/8	16	0.3750	0.3344	0.3407	0.3073	0.3141
7/16	14	0.4375	0.3911	0.3981	0.3602	0.3679
1/2	13	0.5000	0.4500	0.4574	0.4167	0.4251
9/16	12	0.5625	0.5084	0.5163	0.4723	0.4813
5/8	11	0.6250	0.5660	0.5745	0.5266	0.5364
3/4	10	0.7500	0.6850	0.6942	0.6417	0.6526
7/8	9	0.8750	0.8028	0.8128	0.7547	0.7667
1	8	1.0000	0.9188	0.9299	0.8647	0.8782
1 1/8	7	1.1250	1.0322	1.0446	0.9704	0.9858
1 1/4	7	1.250	1.1572	1.1696	1.0954	1.1108
1 1/8	6	1.500	1.3917	1.4062	1.3196	1.3376
1 3/4	5	1.750	1.6201	1.6370	1.5335	1.5551
2	4 1/2	2.000	1.8557	1.8741	1.7594	1.7835
2 1/4	4 1/2	2.250	2.1057	2.1241	2.0094	2.0335
2 1/2	4	2.500	2.3376	2.3580	2.2294	2.2564
2 3/4	4	2.750	2.5876	2.6080	2.4794	2.5064
3	4	3.000	2.8376	2.8580	2.7294	2.7564

[1] Basic diameter.

[2] Dimensions given are allowable only with tap having theoretically sharp corners. Threaded hole must not reject correct basic "Go" gage by interference with rounded roots due to worn tap. Minimum flat at root equals $1/16 \times p$.

[3] The tolerances specified for pitch diameter are cumulative and also include errors of lead and angle.

NOTE: For numbered sizes of nuts see also Table 7, page 16

Table 25 Fine-Thread Series—Loose Fit (Class 1) —Nuts

1	2	3	4	5	6	7
Size	Threads per Inch	Minimum Major[1] Diameter[2] (Inches)	Pitch Diameter[3]		Minor Diameter	
			Minimum (Inches)	Maximum (Inches)	Minimum (Inches)	Maximum (Inches)
0	80	0.0600	0.0519	0.0543	0.0465	0.0478
1	72	0.0730	0.0640	0.0665	0.0580	0.0595
2	64	0.0860	0.0759	0.0785	0.0691	0.0708
3	56	0.0990	0.0874	0.0902	0.0797	0.0816
4	48	0.1120	0.0985	0.1016	0.0894	0.0917
5	44	0.1250	0.1102	0.1134	0.1004	0.1029
6	40	0.1380	0.1218	0.1252	0.1109	0.1136
8	36	0.1640	0.1460	0.1496	0.1339	0.1369
10	32	0.1900	0.1697	0.1735	0.1562	0.1596
12	28	0.2160	0.1928	0.1971	0.1773	0.1812
1/4	28	0.2500	0.2268	0.2311	0.2113	0.2152
5/16	24	0.3125	0.2854	0.2900	0.2674	0.2719
3/8	24	0.3750	0.3479	0.3525	0.3299	0.3344
7/16	20	0.4375	0.4050	0.4101	0.3834	0.3888
1/2	20	0.5000	0.4675	0.4726	0.4459	0.4513
9/16	18	0.5625	0.5264	0.5321	0.5024	0.5084
5/8	18	0.6250	0.5889	0.5946	0.5649	0.5709
3/4	16	0.7500	0.7094	0.7157	0.6823	0.6891
7/8	14	0.8750	0.8296	0.8356	0.7977	0.8054
1	14	1.0000	0.9536	0.9606	0.9237	0.9304
1 1/8	12	1.1250	1.0709	1.0788	1.0348	1.0438
1 1/4	12	1.2500	1.1959	1.2038	1.1598	1.1688
1 3/8	12	1.5000	1.4459	1.4538	1.4098	1.4188

[1] Basic diameter.

[2] Dimensions given are allowable only with tap having theoretically sharp corners. Threaded hole must not reject correct basic "Go" gage by interference with rounded roots due to worn tap. Minimum flat at root equals $1/16 \times p$.

[3] The tolerances specified for pitch diameter are cumulative and also include errors of lead and angle.

NOTE: For numbered sizes of nuts see also Table 15, page 23.

of pitch diameter tolerance (E') absorbed by a variation of a' in half angle of thread is, for symmetrical threads

$$\cot a' = \frac{h}{E' \sin a \cos a} \pm \cot a$$

where h = depth of thread
a = half angle of thread
a' = error in half angle

The sign of cot a is plus when the half-angle of thread is less than the basic by a' and minus when the half angle is greater than basic. The approximate mean

values for a' and E' will be obtained when plus or minus cot a is omitted from the above formula. For American (National) Form of Screw Thread the depth of thread $h = \frac{3}{4} p \cot 30$ deg. and $a = 30$ deg.
Substituting, the formula becomes

$$\cot a' = \frac{3p}{2E'}$$

or $$E' = \frac{3p}{2} \times \tan a' = 1.5\, p \tan a'$$

For all practical purposes, the equivalent pitch diameter corrections for any angular error can be taken as proportional to the values given in the above tables. For example, on the ⅜–18 thread, an angular error of 1 deg. 25 min. is equivalent to a pitch diameter error of 0.00206 in. An angular error of 17 min. or ½ the amount given in the table is equivalent to 0.00041 in. which is almost directly proportional.

Appendix C

TOLERANCES FOR LOOSE FIT (CLASS 1)

This fit is recommended whenever an *allowance* is required between the maximum screw and the minimum nut, and in the cases where larger tolerances than those given by the Free Fit (Class 2) are needed.

This class of screw threads will be defined and specified as follows:

Minimum Nut is Basic.

Maximum Screw is below Basic.

The major diameter and pitch diameter of the maximum screw will be below basic in accordance with the diameter specified in Tables 22 and 24.

Direction of Tolerance on the Nut: The tolerance on the nut will be plus.

Direction of Tolerance on the Screw: The tolerance on the screw will be minus.

Tolerance Values: The tolerances on a screw or nut of given diameter and pitch will be such as to result from the dimensions given in Tables 22, 23, 24 and 25.

A Method for the Measurement of Internal Stress in Brass Tubing

A paper by R. J. Anderson and E. G. Fahlman, recently issued by the Bureau of Standards, describes a new method for the quantitative estimation of longitudinal internal stress in tube shapes, cold-drawn brass tubes being used for example. It was shown that the major stress is longitudinal, and the stress in the outer part of the wall of the tubing is a longitudinal tensile stress, while that in the inner portion is a longitudinal compressive stress. The summation of the balanced stresses, of course, is zero.

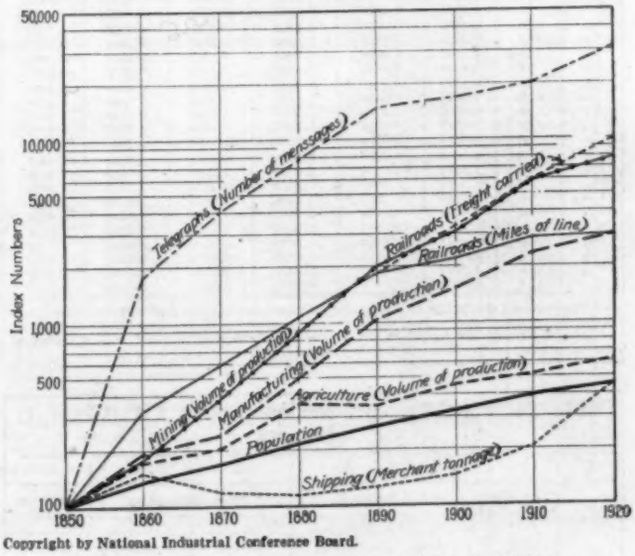
Absence of circumferential stress in tubes is indicated by the failure of diametrically-cut rings to spring in or out on being slit in two. Experiments showed that the usual cutting methods which have been applied to bars and rods for the estimation of stress are not applicable to tubes, especially where the bulk of the stress is longitudinal.

The method described in the paper for measuring longitudinal internal stress is called the strip method, and is carried out by slitting a narrow strip longitudinally in a piece of tubing—for instance, a strip 2.75 in. long and 0.10 in. wide in a 3.25-in. tube length—and then releasing one end of the strip by cutting. Stress is indicated by the springing out of the free end and can be calculated by means of a formula based on the modulus of elasticity of the material and the distance moved by the free end.

The method is useful for determining the amount of stress in cold-drawn tubes, and for examining quantitatively the effect of low-temperature anneal upon stress release. It has often been thought that because cold-drawn brass does not crack on application of an accelerating cracking agent, it is free from internal stress. The strip method is applicable for the quantitative estimation of stresses inferior to those necessary for cracking under the application of mercurous nitrate.

Economic Progress in the United States

An investigation recently made by the Industrial Conference Board of the economic progress of the United States during the past 70 years reveals that throughout this period industrial development has kept well ahead of the actual needs of the people. Prior to 1850, the United States was dominantly an agricultural country and much of it had not been developed. The accompanying chart shows that between 1850 and 1920 the population of the United States increased 3.6 times, but the physical production of agricultural crops rose



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Economic progress of the United States

about 5.2 times, that of manufacturing increased 28 times, and that of mining over 77 times.

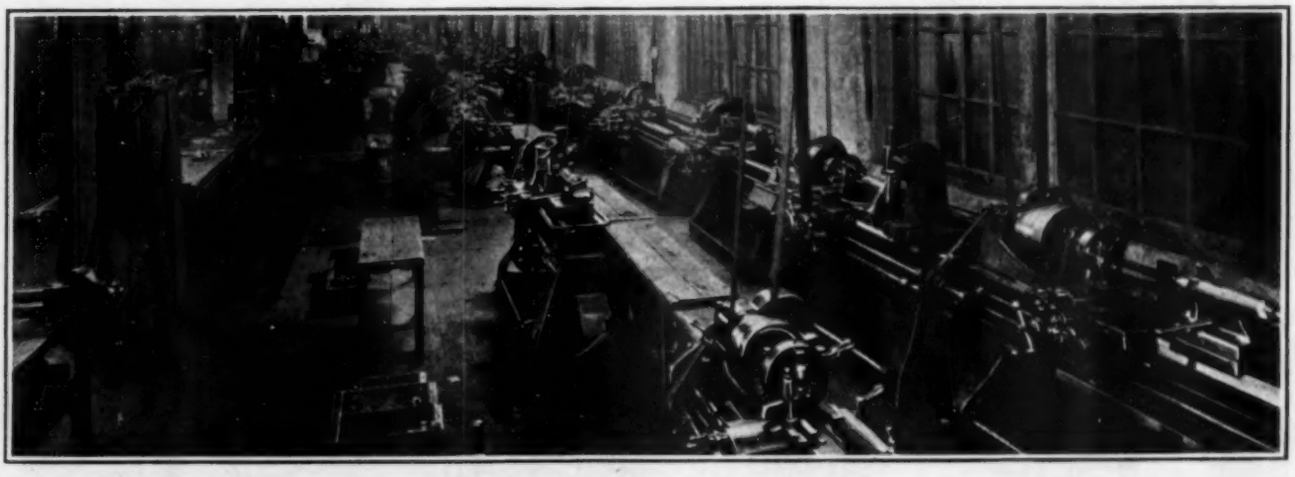
This enormous increase in production was accompanied—and entirely accomplished—by an increase of approximately 3.6 times in shipping tonnage and 28 times in miles of railroad lines, aside from a considerable expansion of auto truck transportation and extensive highway and waterway construction. With the exception of shipping tonnage, every one of the items on the chart shows an increase that is above the increase in population. This would indicate that from an economic point of view, the population of the United States is considerably better off than it was in 1850. There is more food, more manufactured goods, more mining production available per unit of population now than there was two, three or four generations ago.

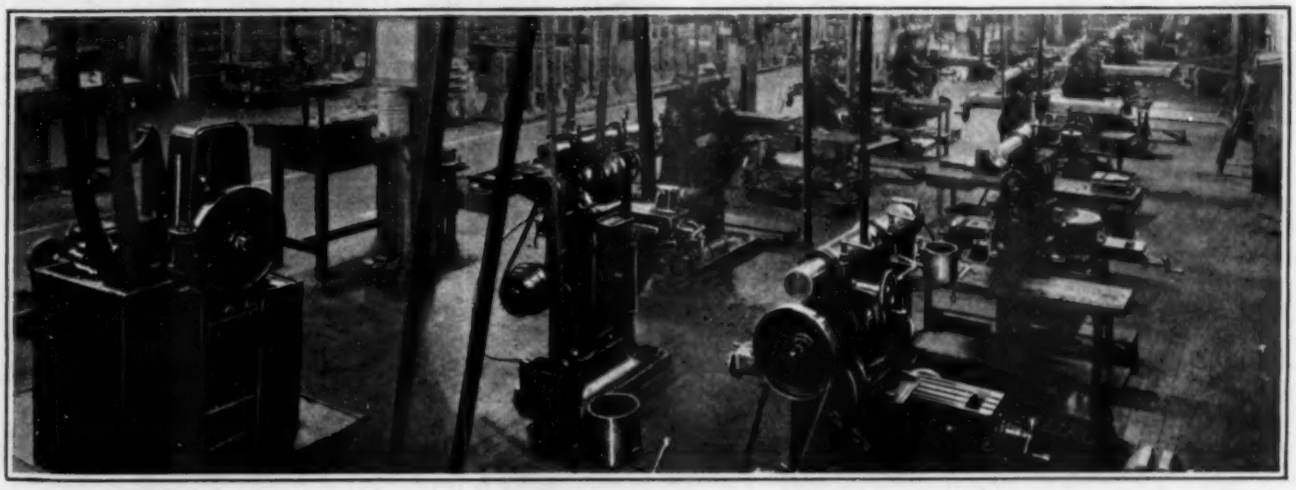
Where Machine Tools Are Made

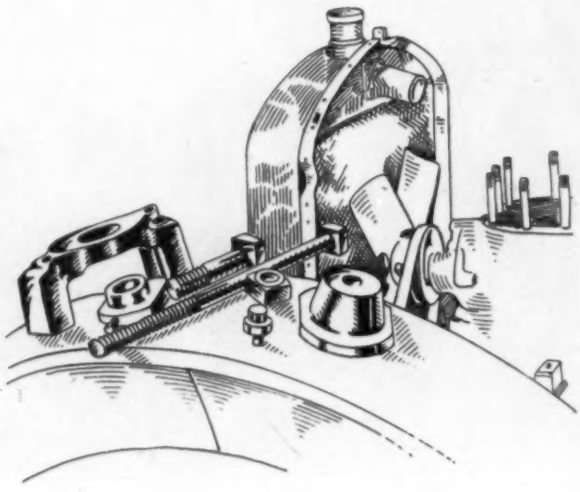
The Oesterlein Machine Company

Cincinnati, Ohio

Founded 1886







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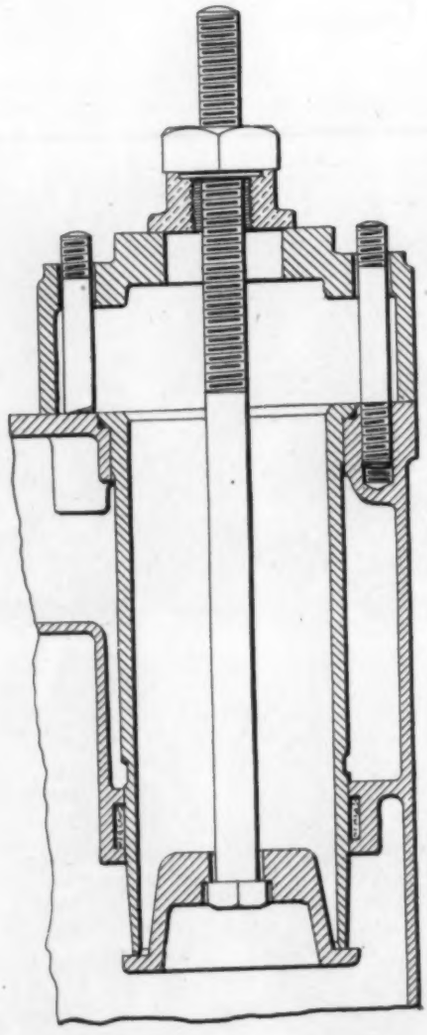

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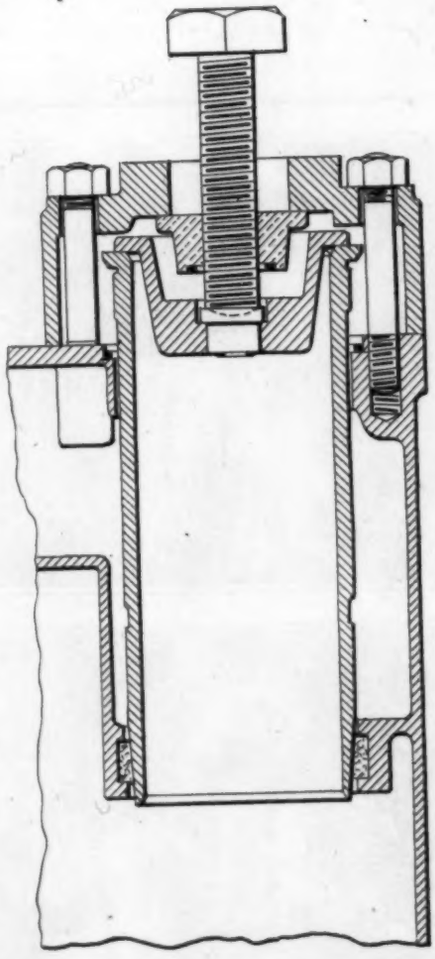

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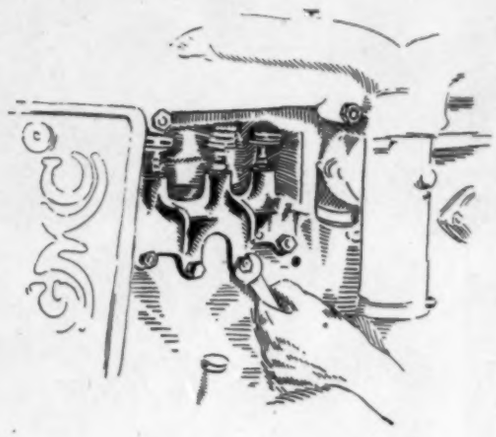

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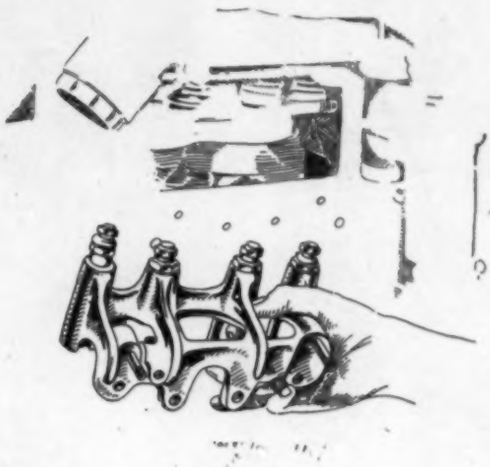

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G M C Truck Service Hints

Fig. 1—Tools for removing cylinder sleeves

Fig. 2—Pulling a sleeve

Fig. 3—How the apparatus works

Fig. 4—Forcing in a new sleeve with same apparatus

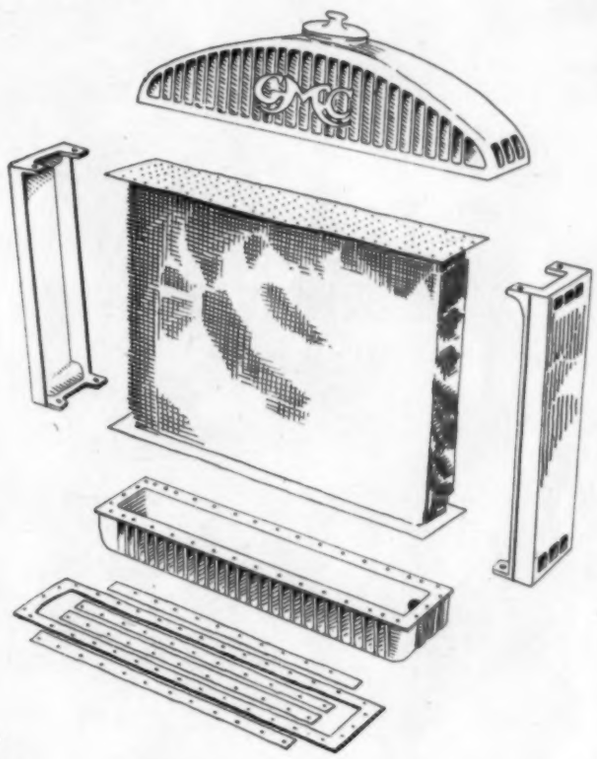
Fig. 5—Taking out valve lifter group

Fig. 6—Valve lifters removed

Fig. 7—The sectional radiator

Fig. 8—Two methods of holding pistons for turning

Fig. 9—Shackle pin puller



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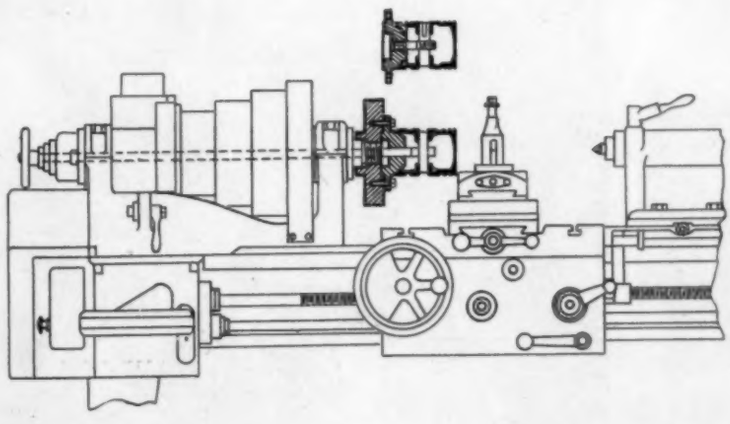

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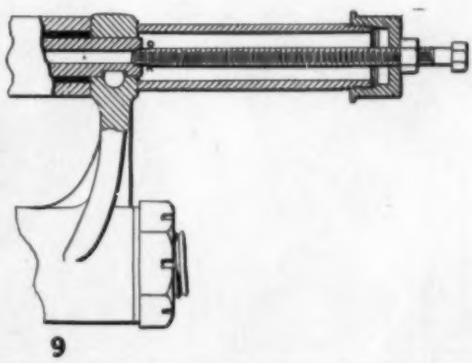

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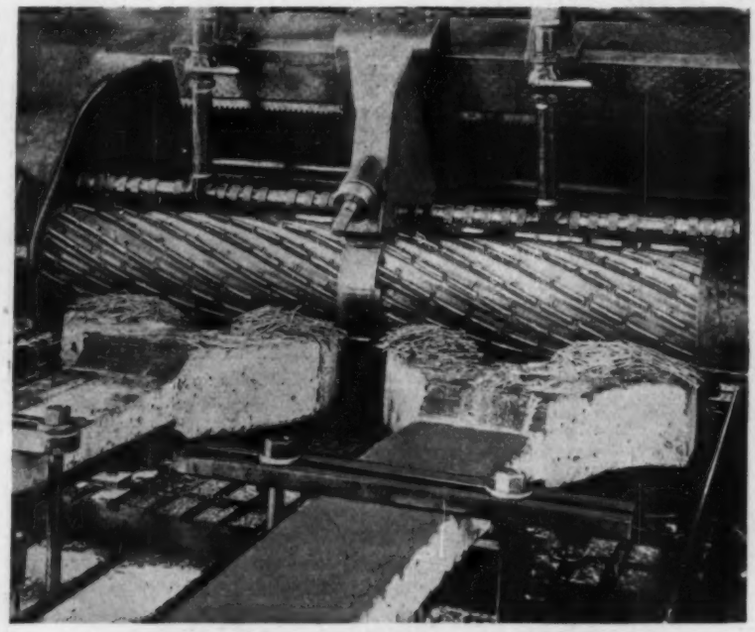
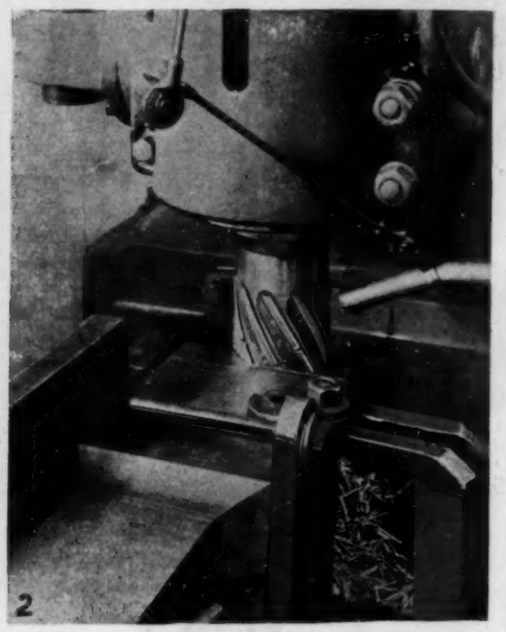
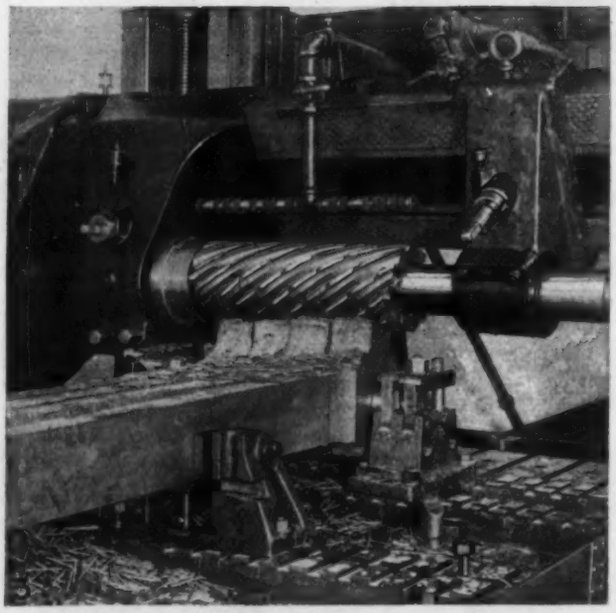






Heavy Railway-Shop Milling

Fig. 1—Chrome-vanadium main rods. Cut 21 in. wide. 9x24-in. helical inserted-tooth slab cutters. Note center bearing

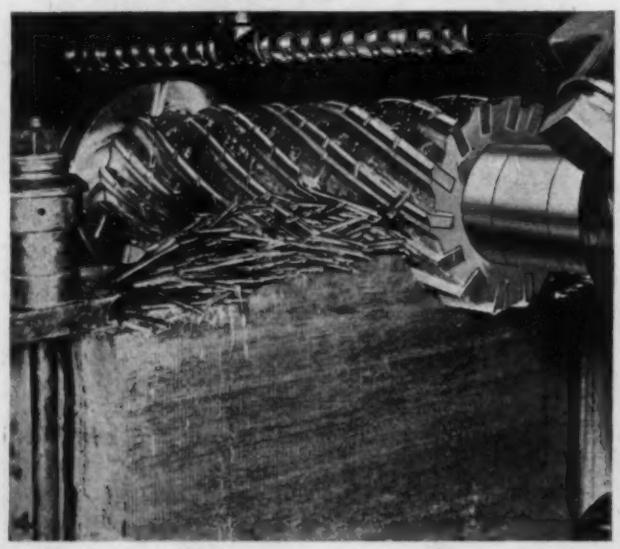
Fig. 2—Squaring ends of two chrome-vanadium rods with 5x12-in. helical inserted-tooth cutter with end support. Cutting speed 35 ft. Feed 1 in. per minute

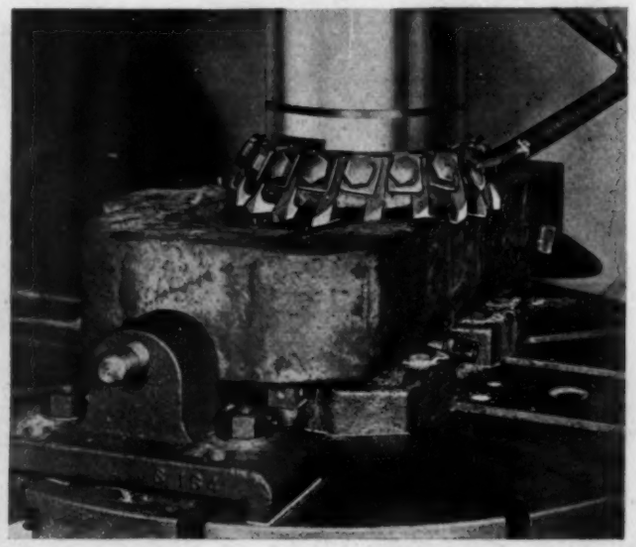
Fig. 3—Edging four carbon-steel side-rods with 9x24-in. cutter. Cut 13–32 in. deep by 12 in. wide. Cutting speed 52 ft. per min. Feed 8¾ in. per min., removing 43.27 cu.in. of metal per min. and consuming 43.6 hp. Floor to floor time 4 hr. 5 min. for both sides of four rods; could mill eight rods in same time

Fig. 4—Slabbing two carbon-steel rods. Cut 2½ in. by 6 in. wide, with 9x24 in. cutter. Feed 3¼ in. per min., removing 49 cu.in. of metal per min. and consuming 53 horsepower

Fig. 5—Face milling locomotive rod strap on rotary machine with type-B cutter

Photographs by courtesy of Ingersoll Milling Machine Co.





Automotive Production

Machining Parts for Four-Wheel Brakes

By Howard Campbell
Western Editor, *American Machinist*

Machining operations on cylinders for hydraulic brakes—A good disk-grinding fixture—A fixture for internal grinding—How the cylinder is tested—Machining the piston

THE introduction of four-wheel brakes has presented a mechanism that is new to the automotive-production field. Many of the axles that are supplied by the Timken-Detroit Axle Co. are equipped with brakes of the hydraulic variety, which are similar in construction and appearance to the usual brake, with the exception that the leverage necessary to expand and contract the brake band on the hydraulic brake is obtained through the medium of a small cylinder and a piston, pressure being applied by means of a liquid. In Fig. 1 is shown a drawing of the cylinder and piston.

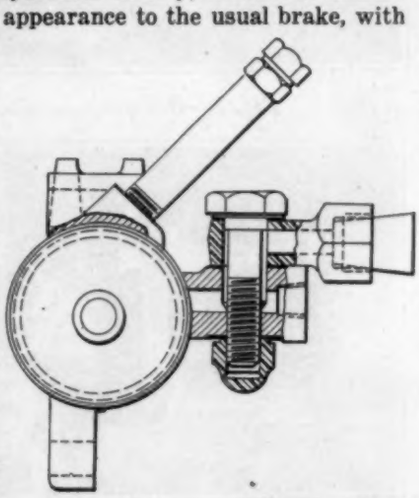
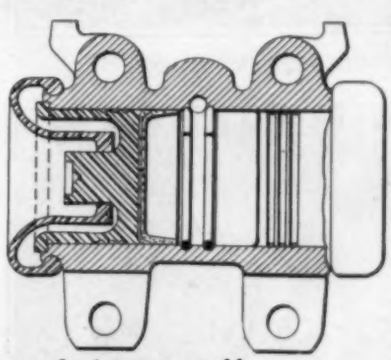


Fig. 1—Drawing of cylinder and piston assembly

The cylinder is of cast iron and the first machining operation, which is that of boring the barrel, is done in the Foote-Burt 4-spindle drill shown in Fig. 2. Each piece is held in a "Self-Clamp" jig, which allows the pieces to be changed instantly by the operation of a lever. The holes are 1¼ in. in diameter in the rough and are drilled to 1⅛ in. in diameter, the drills cutting at a speed of 87 ft. per min. Compound is used as a coolant.

There are two lugs on the side of the cylinder, each of which is finished on both sides. The operation is performed in an Ohio continuous milling machine, Fig. 3, and the fixture in which the pieces are held is so constructed that the four faces are finished on four pieces at a time, as shown, from $\frac{5}{16}$ in. to $\frac{1}{8}$ in. of stock being taken off each lug. The table indexes, feeds in to the required depth, backs away and indexes again, the operation being entirely automatic. The operator removes and inserts the cylinders while the cutters are working. Thumb screws hold the pieces in place and simplify the matter of changing them. A production of 190 pieces per hour is obtained on this operation.

As the ends of the lugs cannot be allowed to project beyond a given dimension from the center of the cylinder bore, they are ground off. This operation is done on a Besly disk-grinder with a special fixture, shown in Fig. 4. The fixture consists of a small angle-plate with locating points for the lugs of the cylinder to rest upon and an expansion bolt that grips the inside of the hole when the nut is tightened. The angle plate is attached to a table that is controlled by rack and pinion, the pinion being operated by means of a hand lever as shown. A wheel dresser is carried on a small base of its own, which is keyed and bolted to the table so that it can be moved forward when wanted. From $\frac{1}{16}$ in. to $\frac{1}{16}$ in. of stock is ground off and a production of 180 per hour on this operation is obtained.



The next operation is that of reaming, which is done in a Colburn 4-spindle drill, Fig. 5. The pieces are held in jigs that set between two rails on the table of the machine, the rails allowing the jig to center itself as the reamer starts into the hole in the work, yet preventing the jig from turning. The reamers are of the inserted-blade type with pilots that enter corresponding bushings in the bottom of the jig. The reamers are 1.495 in. in diameter, and remove $\frac{1}{16}$ in. of stock at a speed of 40 ft. per minute, feeding 0.029 in. per revolution. Production is 200 pieces per hour.

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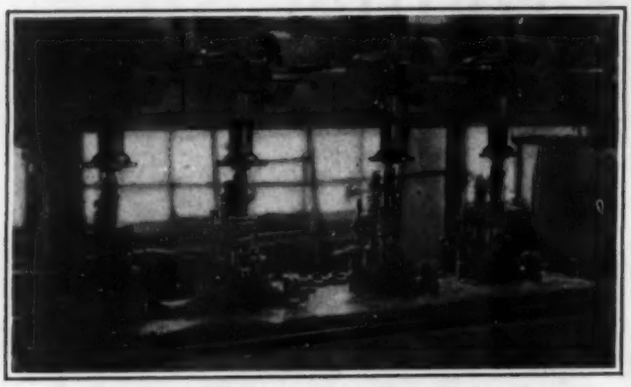

Fig. 2—Drilling hydraulic brake cylinders

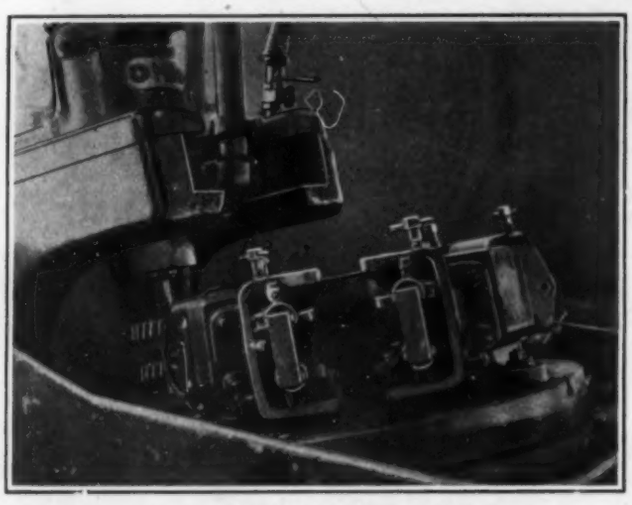

Fig. 3—Milling lugs on cylinders

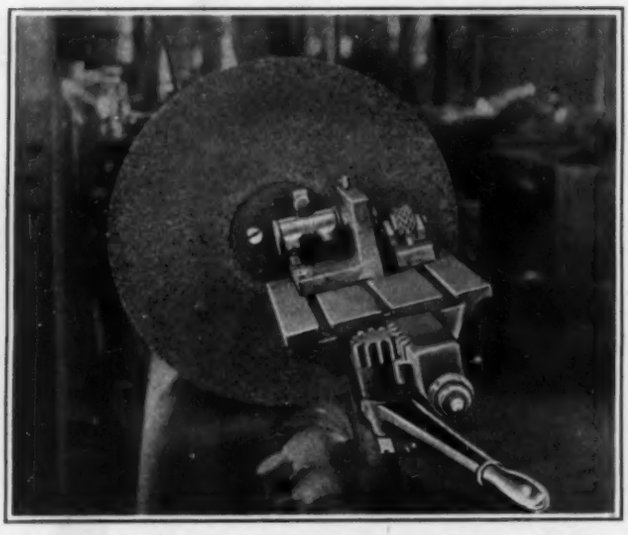

Fig. 4—Lugs are ground on the disc grinder

The cylinder bore is ground in a Heald internal grinding machine, shown in Fig. 6. The piece is located against a plate, shown at *A*, and is locked in position by the action of an air-plunger which extends through the spindle of the machine. A 1⅛-in. diam. 36-K Norton Crystolon wheel is used, running at a speed of 12,400 r.p.m. and washed with a mixture of three parts water and one part kerosene. This mixture was found, after many experiments, to produce the best results, considering the metal and the speed of the wheel. From 0.005 in. to 0.006 in. of stock is removed and the diameter of the hole is held within 0.002 in., which is determined with the aid of a go and no-go gage. Forty-three pieces per hour is the average production on this job.

The piston for the hydraulic brake cylinder is made of aluminum and is machined in the Bardons & Oliver turret lathe shown in Fig. 7. The piece is held in a Barker chuck and the turning operation is done with

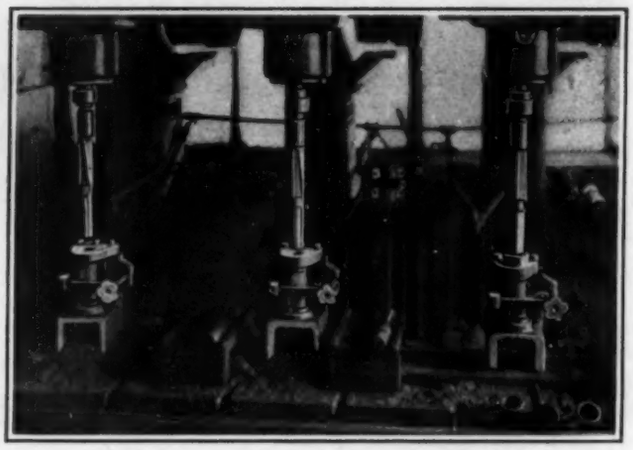

Fig. 5—Reaming cylinder bores

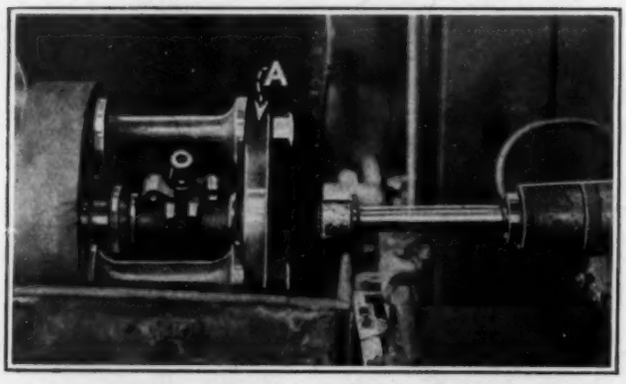

Fig. 6—Grinding bores to size

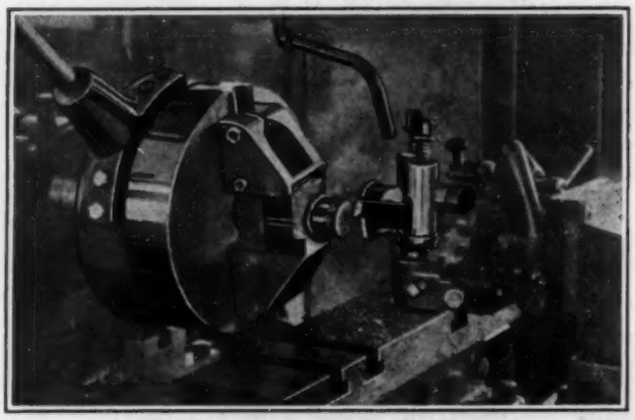

Fig. 7—Making the piston

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a box tool in the turret of the machine, while the facing and grooving tools are located on the cross-slide. A circular formed tool is used for grooving. The ☆ in. of stock is removed in one cut and the diameter is held within the limit of 0.002 in. of drawing dimension. Kerosene is used as a lubricant. A production of 50 pieces per hour is obtained on this operation.

After the cylinders have been completely machined, each one is assembled with its piston and the assembly is placed in a fixture that holds the piston from coming out beyond the normal extreme or "off" position. Air is applied at a pressure of from 60 to 80 lb. and the whole cylinder assembly, with its fixture, is submerged in a tank which contains a mixture of castor oil and alcohol, the same mixture used in service. Observation is then made for the presence of air bubbles which would indicate leaks. After this test has been made, the cylinder is filled with the fluid and the pressure is run up to 1,500 lb. per sq.in. by means of a screw-driven piston. If there are any defects in the piece, it will be unable to survive the test indicated and must usually be scrapped.

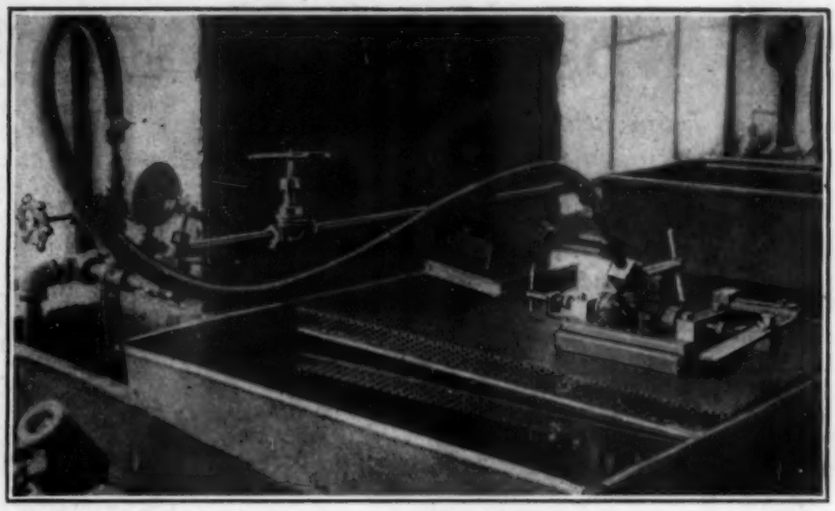


Fig. 8—Testing the Cylinder

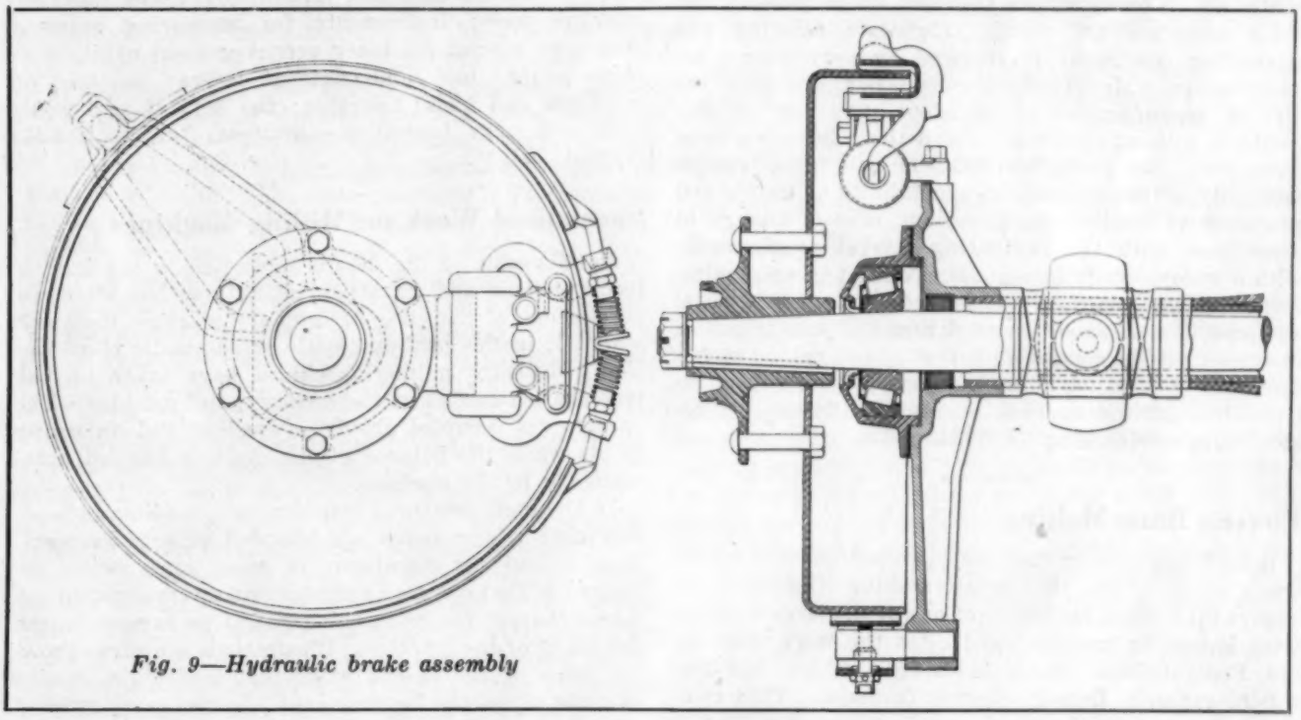


Fig. 9—Hydraulic brake assembly

Production of Leather Belting in 1923

The Department of Commerce announces that, according to data collected at the biennial census of manufactures, 1923, the establishments engaged primarily in the manufacture of leather belting (used for the transmission of power) reported products valued at $37,845,830, an increase of 97.4 per cent as compared with 1921, the last preceding census year.

In addition, leather belting was manufactured to a small extent as a secondary product by establishments engaged primarily in other industries. The value of the belting thus made outside the industry proper in 1921 was $573,158, an amount equal to 3 per cent of the total value of products reported for the industry as classified. The corresponding value for 1923 has not yet been ascertained, but will be shown in the final reports for the present census.

AUTOMOTIVE PRODUCTION

Abstracts

from other publications

British Factory Equipment Flexible

In a survey of British shops Harry Tipper gives as the outstanding characteristics the facts that small quantity lots are dealt in; that there is great flexibility of operation; that stock room methods are simple; that there is more fitting and less tooling; and that lighter materials are used. British shops would be considered under-tooled for many products made and used in America. The large pressing equipment to be noted all through the industry in the United States is almost absent in body making in Great Britain.

There is little opportunity for the British manufacturer to use the many labor saving devices for moving materials. Conveyors are installed where possible but their uses are not many. Elaborate painting and enameling equipment is replaced by very simple arrangements. Mr. Tipper's conclusions are that the British manufacturer could adopt very few of our methods without modification and these in only one or two cases. His production problem calls for maximum flexibility, minimum tooling, adaptability of metals and processes to smaller quantities and ease of change in accordance with the fluctuating market requirements with a wider variety in demand. To meet these requirements he uses mainly standard tools, minimum special equipment, more labor, more fitting and less tolerance in assembly. One conclusion is that in general the manufacturing cost is not notably higher, considering quantity, although the methods are quite different.—*Automotive Industries*, Aug. 14, 1924, p. 320.

Electric Brass Melting

Robert June states that the introduction of the electric furnace into the brass melting industry has changed the whole technique of one of the largest industries known to mankind and cites the work done by the Federal-Mogul Corp. in Detroit which has five 250-lb. capacity Detroit electric furnaces. This company manufactures bearings and bushings of red brass and bronze for the automobile trade. Each furnace is supplied with current through a 100-kw. Kuhlman transformer with Square D switches and recording and indicating meters on the control board. The operation of the furnace is as follows: With the kw.-hr. meter reading zero, the current is turned on, the furnace remaining in a stationary position until the meter reading is 10 kw-hr., when by means of a reversing gear arrangement it is started rocking back and forth. This rocking action, which assures perfect mixing, eliminates rejections due to segregation of the metals. The furnace is kept oscillating until the metal reaches pouring temperature, determined by the heat input as indicated by the kw.-hr. meter. The total elapsed time of the run, including charging, melting and pouring, averages about 23 min.

The weight of the charges runs up to 250 lb., common practice being 18 or 19 heats in an 8-hr. working day. Coke-fired furnaces were capable of only 5 heats per 8-hr. day. The life of furnace linings reaches a possibility of 2,000 heats on an average. One of the advantages of this installation has been the elimination of the need for skilled melters.—*The Iron Age*, Aug. 14, 1924, p. 371.

Technical Meetings

It is interesting to note the suggestions put forth by the sections of the Society of Automotive Engineers for meetings this quarter. One subject deals with the design of special tools, jigs and set-ups for flat-rate repair operations. Another is "How can the garage operator determine when various forms of special tools and equipment pay?" There are papers dealing with the value of power-driven tools, and of various overhaul methods; inspection methods and equipment; more accurate screws and tapped holes; new types of machine tools; instruments for measuring extreme accuracy; special machines versus general utility machines; jig, tool and fixture design; salvage of machines and tools; tolerance; the field of spot welding; and wage incentives.—*Sections Bulletin S.A.E.*, August 20.

Specialized Work on Milling Machines

Development of the details of design in the milling machine itself and the attendant fixtures has lifted the former out of the class of ordinary machine tools and placed it in the semi-automatic or automatic classification. Recently milling machines have taken on the true characteristics of the cyclic type of machine. The operator is occupied chiefly in loading and unloading pieces while the balance of the cycle is handled automatically by the machine.

In the most improved combinations, loading and cutting time requirements are balanced to produce maximum output per man-hour, in many cases being arranged so that one man operates two or three machines. These characteristics are obtained at no expense to the flexibility of the machine. Illustrations are given showing some of the special work that is done, a specific example being the bearing ends of crankcases finished at the rate of 60 per hour.

The illustrations show a special head for finishing surfaces or gear boxes used on the No. 5 Cincinnati and for milling cylinder heads; a ten-station rotary fixture and special head for high production; a special fixture for milling splines on forged steel clutch hubs; a standard fixture and machine for milling bearing ends; a machine for milling bearing bosses; a special fixture for milling unusual splines in rear axle ends; a fixture for milling universal joint members where two pieces are clamped by one cam; and a fixture for form-milling windshield brackets.

A significant feature of these examples is that only standard machines are used and that the rapid production is secured by means of special fixtures in connection with cutters designed or selected for the particular job. —*Automotive Industries*, Aug. 21, p. 356.

How to Estimate Machine Shop Costs

By Albert A. Dowd

Further consideration of thread cutting estimates—Examples of the use of thread milling machines—The making of estimates for hobbing and tapping threads

COARSE pitch Acme and square threads can be cut on an engine lathe and the automatic threading lathe, or the Acme thread can be cut on a thread milling machine. When only two or three pieces are required, the engine lathe is generally used, but for a number of pieces or a production job a more rapid method should be employed. For the purpose of estimate we need consider only the threading lathe and thread milling machine, the former machine using a lathe tool for removing stock while the latter employs a milling cutter of suitable shape or a hob cutter.

In estimating the time consumed in milling a thread on a thread milling machine, we must first consider the material to be cut, next the accuracy required, and finally the quantity to be produced, as all these matters have an effect upon the time consumed. The material used affects the speeds and feeds which can be utilized, and the accuracy of the work also determines these points to some extent. The quantity of work to be manufactured affects the methods which are to be used. In milling threads a long screw is usually cut with a single cutter but short threads are frequently hobbed.

Thread Milling Methods

When threads are cut by the milling process a revolving cutter takes the place of the regular thread tool used in lathe work, and the work is slowly milled as it revolves. The feeds on the machine are arranged so that the cutter carriage travels a distance equal to the lead of the screw being cut for each revolution of the work. Change gears are provided to obtain the correct ratio. Several speeds for the cutter are available. The kind of cutter used in thread milling is shaped to the form of the tooth required and the teeth are staggered and eccentrically relieved so that they can be ground when dull without changing their shape. The cutting action is essentially one of milling, produced as the work is slowly revolved against the cutter.

The machine is arranged so that after the cutter has been fed in to the proper depth the full amount of the cut is taken while the work revolves and no finishing cut is required. The machine is automatic in its action after the work has been placed in position. The method of holding is by means of a collet in the spindle. A steady rest and tailstock are provided for long work. An indexing device is provided in connection with the collet mentioned so that multiple threads can be cut when desired. Work can be placed in the machine and removed very rapidly so that the time allowance for this item is comparatively small.

This is the twelfth article of the series. The eleventh article was concluded on page 302, Vol. 61, No. 8.

In order that smooth threads may be produced, feeds must naturally be quite fine for this class of thread cutting and the estimator considering thread milling A represents the work and B the cutter. If the latter are circular as shown in the diagram, Fig. 34, in which A represents the work and B the cutter. If the latter has 24 teeth and is revolving at 271 r.p.m., and if the work A is also revolving at the maximum speed of the spindle, 16 r.p.m., then $\frac{271 \times 24}{16}$ = number of teeth in contact during one revolution of the work = 406 (approx.). The work is 2 in. in diameter and, as the pitch is $\frac{1}{16}$ in., the total length of one helix on the outside diameter of the work is $\sqrt{(2 \times 3.1416)^2 + (0.0625)^2} = 6.3$ in. (approx.). Then $\frac{6.3}{406} = 0.016$ in. per tooth of cutter.

A feed as coarse as this would produce a serrated thread with a series of ridges, as shown exaggerated at C. A high-speed steel cutter 1¼ in. in diameter running at 271 r.p.m. gives a cutting speed of approximately 115 ft. per min., which is all right for cutting screw stock or mild steel bars. We could slow the spindle speed down to about 3 r.p.m., or even less if necessary, and allow each chip to be about 0.004 in., thus producing a much smoother thread. Let us take this piece as an example with sizes as follows: diameter 2 in., 16 threads per inch, cut 3 in. long on the bar from one end, spindle speed 4 r.p.m. and cutter speed 271 r.p.m. A formula for the time necessary can be developed as follows:

$$\frac{P \times L}{R} = T$$

in which

P = Threads per in.
L = Length of thread on bar.
R = Revolutions per minute of work.
T = Time required.

Substituting numerical values

$$\frac{16 \times 3}{4} = \frac{48}{4} = 12 \text{ min.}$$

If we select a smaller cutter 1¼ in. in diameter we can use a higher cutter spindle speed, say 346 r.p.m., which would give us a cutting speed about the same as before. Speeding up the cutter also allows the work to be speeded up to about 8 r.p.m. and $\frac{16 \times 3}{8} = \frac{48}{8} = 6$ min.

The nature of the material and the coarseness of the thread affect the feeds and speeds greatly, for it is plain that hard or tough materials and coarse pitches

require finer feeds and slower speeds. The estimator must consider first the kind of material, then the quality of the work, and finally he must set spindle speeds so that the feed of the cutter as work revolves will give the results desired. Slow work spindle speeds and high peripheral speeds for the cutter give the most satisfactory product. The following suggestions may be of value: First figure roughly the length of one turn of the helix; next decide upon the size of the cutter and the speed at which to run it, according to the nature of the material; then the r.p.m. of work should be proportioned so as to produce a feed per tooth giving the desired results.

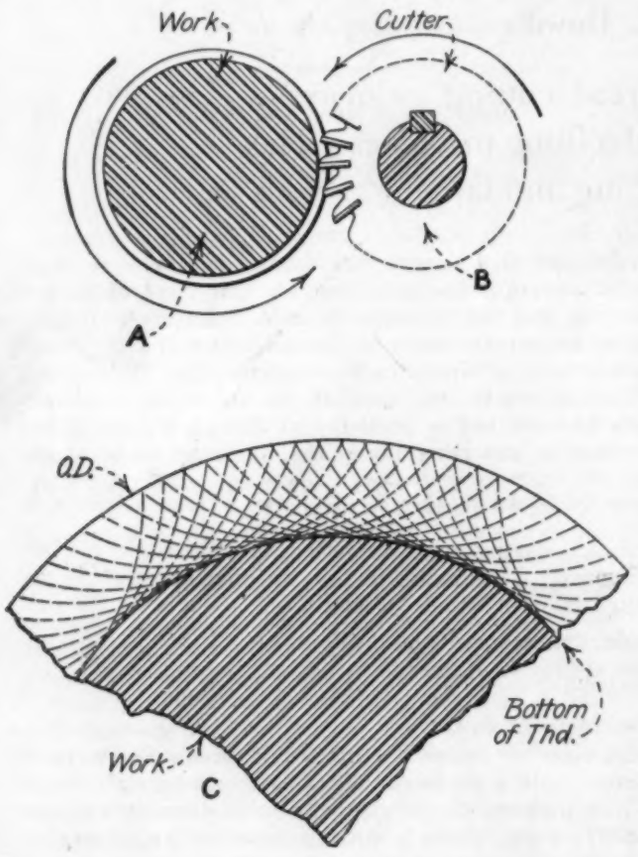


Fig. 34—Diagram of cutter action in thread milling

In the example *A*, Fig. 35, we have a piece of work 9¼ in. long, at one end of which is to be cut a 12-pitch Acme thread 1 in. in diameter and 4 in. long. The material is machine steel and the requirements call for a good commercial thread. The circumference of the piece is 3.1416 in. and we can use a 24-tooth cutter 1⅝ in. in diameter, running at 271 r.p.m. giving a cutting speed of 115 ft. per minute. If we figure a tooth feed of 0.006 in., $\frac{3.1416}{24 \times 0.006} = 21.8$, the number of cutter revolutions for each turn of the work. Then, $\frac{271}{21.8} = 12$ revolutions of work per minute.

Using the formula, we have $\frac{12 \times 4}{12} = 4$ min. for one piece. This time allowance seems reasonable, and would undoubtedly give a good commercial thread. We have not considered the setting up and removing of the work, but this item is a comparatively small one for which a time allowance of 0.6 min. should be ample. The example shown at *B* is a hub of cast steel, at one end of which a 20-pitch U.S.F. thread is to be milled. The diameter at this point is 3½ in. and the length of the thread is ¾ in. The requirements call for a good commercial thread and quantity production. Here we must consider a material which is somewhat hard and is likely to have pits or sand spots in it and, although the inspection of the work previous to the thread milling operation should eliminate the worst of the castings, some bad spots will very likely be found during the milling cut. For this reason even with high-speed steel cutters, the operator would be required to watch the work more closely than on other work where the material is less variable. The thread is rather fine and can be cut rapidly because the amount of metal to be removed is comparatively small.

The circumference is 10.995 in. and we should be able to use a cutting speed of 115 ft. per min. with a cutter 1⅝ in. in diameter. With the cutter spindle running at 271 r.p.m. we will have the result desired. If a tooth feed of about 0.005 in. is used, and if there are 24 teeth in the cutter, $24 \times 0.005 = 0.120$ in. feed per cutter revolution. Then $\frac{10.995}{0.120} = 91.6$ revolutions of cutter required for each turn of the work.

The revolutions of the work per min. will be $\frac{271}{91.6} = 3$, and applying the formula, $\frac{20 \times \frac{3}{4}}{3} = 5$ min.

This speed would give a good commercial job, but it will be noted that the work must be revolved 15 times in order to produce the thread. Under these conditions it would be possible to use a spcial hob cutter of proper size and pitch and revolve the work only once at a somewhat slower speed. This would be good practice and result in increased production. In using a hob cutter it would be necessary to slow the speed down, and it would doubtless be better to make the hob 1¼ in.

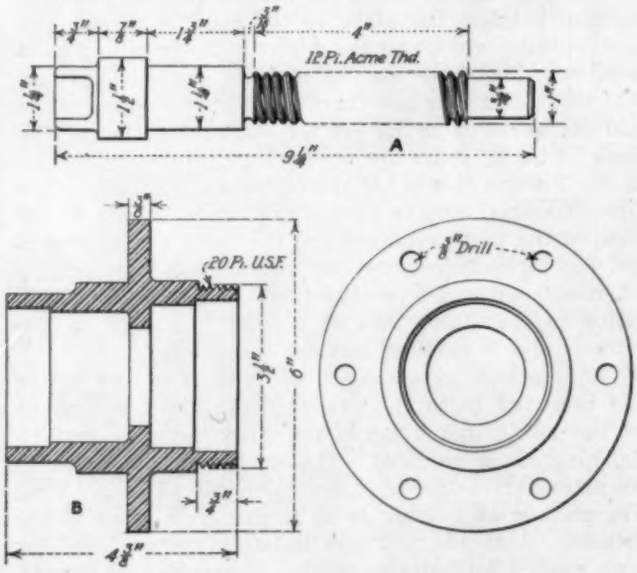


Fig. 35—Examples of thread milling work

in diameter and run it at a speed of 271 r.p.m., giving a cutting speed of about 90 ft. per min. The feed per tooth should also be decreased slightly to about 0.003 in. per tooth. Then, $24 \times 0.003 = 0.072$ in. feed per

revolution of hob, and the revolutions of cutter required for each turn of work $= \frac{10.995}{0.072} = 153$. The revolutions of the work per min. $= \frac{271}{153} = 1.8$. To this must be added the time for setting up which we might consider to be about 1 min., making the total time for one piece 1.5 min. The use of a hob cutter here saves a great deal of time and increases production correspondingly, but it is evident that it should not be used except where threads are short because the overhang of the hob and the increased pressure resulting from the greater number of teeth cutting at the same time, would not be productive of good results. The estimator must take these points into consideration in various thread milling operations.

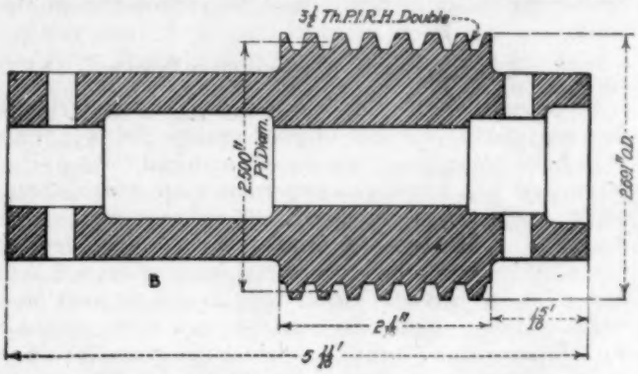


Fig. 36—Double-thread worm as an example of thread hobbing work

In the example in Fig. 36, we have a steel worm with 3½ right-hand threads per in., double, and this piece requires somewhat different treatment from the previous examples. As the thread is double, two cuts are necessary and the work must be indexed between the two operations. The chuck furnished on this type of machine is arranged so that it can be indexed without disturbing the setting of the work. Any multiple thread can thus be cut by indexing the chuck as required to suit the case.

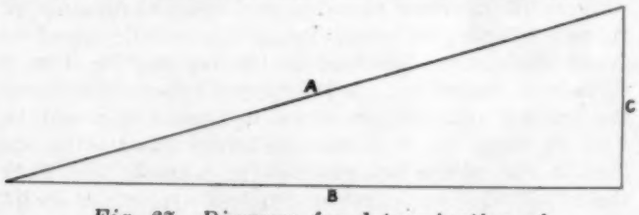


Fig. 37—Diagram for determination of pitch line helix

In cutting this worm we must remember that the pitch of the thread or the number of threads per inch and the lead of the thread are distinctly different, as the latter is double the former. In other words, if the linear pitch of the thread is 0.2857 in., the lead for a double-thread worm would be 0.5714 in. The length of the pitch line spiral will be determined as shown by diagram in Fig. 37. If we assume B = circumference of work on the pitch line, C = lead of the worm thread and A = length of spiral, then $\sqrt{(B)^2 + (C)^2} = A$. Substituting the numerical values, $\sqrt{(7.85)^2 + (0.571)^2} = 7.87$ in. approximately, which is the length that cutter travels on the pitch line in one turn of the work.

This is worm of 0.50 carbon steel and it should not be machined at too great a speed. The feed per tooth of cutter can be about 0.001 in., giving 0.024 in. feed for each cutter revolution. As the cutting speed for this kind of material should not be higher than 90 ft. per min., even with a fine feed, we must use a cutter 1¼ in. in diameter with 24 teeth, running at 271 r.p.m. Then, as the length of the spiral cut has been found to be 7.87 in. for one revolution of the work and as the cutter takes 0.024 each time it revolves, $\frac{7.87}{0.024} = 328$ revolutions to one turn of the work. $\frac{271}{328} = 0.82$ turns of the work per min.

We can, therefore, use a speed for the work of approximately 0.75 turn per min. Under these conditions the formula given previously cannot be used and we should substitute the following:

$$\frac{N \times T}{R} = P$$

in which

N = Number of turns of work per inch of travel.
T = Longitudinal travel of work in inches.
R = Revolutions of work per min.
P = Time for one cut the length of the work.

Substituting the numerical values,

$$\frac{1\frac{1}{4} \times 2\frac{1}{16}}{0.750} = 4.87 \text{ min. for one cut.}$$

To this amount must be added the index time and the return of the carriage for the second cut, say 1 min.; also the time allowance for setting up and removing the work which may be 1.5 min. Then the total time for one piece is 12.24 min.

Any multiple thread estimate can be worked out in the same manner as this, but if the worm is to be hardened and ground after cutting, it is possible to use much coarser feeds because the tooth marks present a surface to the grinding wheel which allows easy removal of stock. The consideration of any piece of estimating usually involves other operations either prior or subsequent to the one on which the estimate is being made. Lack of foresight on the part of the estimator may cause the loss of a valuable production job on account of too great a time allowance for finishing a piece of work which is afterward to be hardened and ground.

Quite recently a new full-automatic thread hobbing machine has been placed on the market by a well-known machine-tool manufacturer, and it seems advisable to include data regarding the estimating of thread cutting time on this machine. In reality it is a two-spindle thread milling machine, intended for milling external threads on comparatively small pieces at a cost much less than would be possible on the regular type of machine. The time in which threads can be produced compares favorably with that for dies and chasers. In addition to this the product is superior to the other method, as the threads are more accurate, both as to diameter and pitch.

Briefly the machine is suitable for small parts, having a diameter not greater than 1 in. and a length of not more than 6 in. and has the standard form of magazine attachment. The hobs are arranged on a slide which is cam-operated, and by means of which the hobs are fed in to the proper depth. The lead of the thread is controlled by a cam having two surfaces operating in sequence, so that one complete revolution of the cam completes two pieces of work. Either right-hand or

left-hand threads can be cut on the machine and one right-hand and one left-hand thread can be cut simultaneously by means of a special arrangement.

In estimating the time necessary for work on this machine it is evident that the time required for hobbing is one turn of the work, but as both spindles are working simultaneously there is no lost time except that required for the chucking and removing operation. These movements all being controlled by a cam, it is evident that one revolution of the cam completes two pieces. The speed of revolution of the cam determines the production. It is suggested that the estimator who is interested should obtain first-hand information regarding the relative speeds on this type of machine.

In estimating thread milling operations there are occasionally cases of a special nature such as two threads of different diameters and pitches on the same piece of work, and there are also studs with a right-hand thread on one end and a left-hand thread on the other. If these pieces are not too large they can in many cases be machined on the thread hobbing machine, since cam arrangements can be made to suit the particular case.

The cutting of internal threads by the milling process requires that the machine be specially arranged for it when purchased. It cannot then be used for external work, and only when production is great enough to warrant it should a machine of this type be purchased. In the event that it is found necessary to estimate on the cutting of internal threads on a thread milling machine, the data which has been given will be found sufficient to give the method. There may be differences in the cutter sizes and in the ratios of speeds, but the principles used are exactly the same as in outside threading.

The Automatic Threading Lathe

In cutting threads on the automatic threading lathe the estimator must consider the problem as a similar one to that involved when cutting the threads on an engine lathe. The arrangement of the machine, however, and the automatic features make possible much more rapid work and considerably greater commercial accuracy. Rigid tool support and improved methods of steady resting the work allow heavier cutting and there is, therefore, a great gain in production.

In making estimates on the tapping of holes a great deal depends upon the human factor. Much also depends upon the class of work, the kind of material. the accuracy required and the machine used for the work. When single tapped holes of moderate size are to be made in the end of cylindrical work, the tapping is frequently done on a screw machine or turret lathe in combination with other operations such as turning, facing, and boring. A tap is held in a releasing tap holder and the machine is reversed for backing out the tap when a small hole is to be threaded. Larger holes are threaded with a collapsing tap which shuts up after the thread is cut so that it can be pulled out of the hole without reversing the machine. In very large inside work the threads may be cut with an internal threading tool or chased out by a special chaser suitably mounted in a bar. Certain kinds of tapping work, such as the tapping of standard nuts, have been made the subject of special study, and as a consequence highly efficient machines have been developed for these purposes.

For the tapping of holes in plain flat surfaces such as cylinders, crankcases and the like, multiple-spindle machines are used, the spindles being adjustable for center distances and sometimes also for height. These machines are not commonly used for small lots as there is considerable labor involved in the setting up and adjustment of the spindles. Any machine tapping operation is likely to give trouble now and then through the breaking of taps, and such contingencies should be taken into consideration when making time allowances. Not only must the tap be replaced by another but the broken tap must in many cases be removed from the work.

Estimates for Tapping Operations

In estimating the time for tapping, the material is first considered, cast iron of good quality and free from blow-holes being about the easiest material for tapping. Mild steel and brass are somewhat more troublesome, while alloy steels are very difficult, even if well-annealed. Speeds used for tapping vary greatly according to the kind of material, size of tapped hole and pitch of thread. Small taps are very weak and break easily; therefore they must be run slowly in order to minimize this trouble as much as possible. For machine tapping in sizes up to ¼ in. in diameter, it is often necessary to use a cutting speed not greater than 15 ft. per minute in steel and possibly 20 ft. or less for cast iron. In reality a high cutting speed for a tap is not a great factor in production, for a slower speed is less likely to cause trouble and may thus offset the gain which might otherwise be found in the higher speed. As taps increase in size they are stronger and will permit slightly greater speed, but it is seldom that this can be increased to more than 30 ft. per minute.

Let us take as an example a flat plate of cast iron in which twelve ½-in. holes are to be tapped, 13 threads per inch. These holes are to be tapped on a multiple-spindle machine with the spindles set so that there is one over each hole. The material to be tapped is ¾ in. thick and it is set up so that the taps run completely through it. If these taps are run at approximately 20 ft. per minute, we would require a spindle speed of about 160 r.p.m. The lead of the tap may be 4 or 5 threads in length and, as the tapped hole is ¾ in. long, the number of turns required to thread it would be $\frac{3}{4} \times 13 = 9\frac{3}{4}$, to which must be added about 5 threads for the lead of the tap, making $14\frac{3}{4}$ turns in all. Thus the actual tapping operation requires approximately 15 revolutions of the tap which is running at 160 r.p.m., or about 0.093 min.

This time is for the cutting of the thread only and does not include bringing the spindles down close to the work, nor does it include the reversal of the spindles and the removal of the taps from the work. The reverse speed is usually at least double the tapping speed. We might allow, therefore, about the same amount of time for the approach and removal of taps from the hole. This would give $0.093 + 0.10 = 0.193$, which could be considered as 0.20 min., or 12 seconds.

This may be considered as normal time for a piece of this sort, but the operator will spend considerably more time than this in setting up the work on the machine table and taking it off again, even if he is provided with a locating jig. If the work is 12 in. long by 8 in. wide and can be easily set in position with simple clamps, the operator might be able to do it in about 0.50 min. This amount added to the allowance above gives 0.70 min., which seems reasonable production. Yet in tapping a lot of 500 pieces, not including the

setting-up time of the machine, this estimate would not be sufficient because of lost time on account of broken taps and minor troubles. It would be well to add to the production time at least one hour and an extra hour for setting up the machine. The machining time for 500 pieces would be 500 × 0.70 = 350 min. = 6 hours and the addition of two hours for setting up and contingent time gives a total of 8 hours for the job.

If this same piece of work were to be done under a single-spindle tapping machine, the tapping time for each hole would be about the same or a trifle less than that given above due to the greater ease in handling the spindle, say 0.15 min. There are 12 holes to tap at this speed requiring 1.80 min. The operator must shift and bring each hole under the spindle before he brings the tap down to the work and we should therefore allow not less than 0.03 min. for each shift or 0.36 min. To this must be added also the placing of work on table and removing it, for which we can allow 10 seconds or 0.17 min. The total time for this piece would then be 1.80 + 0.36 + 0.17 = 2.33 min.

In tapping larger work with collapsing taps, the speeds vary from 15 to 25 ft. per min. depending upon the material, the number of turns being determined by the length of thread and the pitch. As an example let us take a steel hub which has a 3-in. U.S.F. thread, 20 threads per inch, cut on one end for a distance of 1 in. This would obviously require 20 turns of the work to complete, and if we add to this three or four extra turns we will have 24 turns. If the work is revolving at a speed of 20 ft. per min., or at about 27 r.p.m., 0.89 min. will be the cutting time. The removal of the tap would be done by hand, five seconds being an ample allowance. We should allow for the entire tapping operation, 0.89 + 0.085 = 0.975 min., and 1 min. for the operation would be sufficient.

Sometimes it is desirable to chase a thread of this kind with a single-point tool, using a chasing attachment on the turret lathe. The time for this operation would be almost the same as if done on an engine lathe, except that the return stroke would be much quicker and would not need as great allowance as on the engine lathe. Sometimes a multiple-point chasing tool is used instead of a single-point tool, but the chasing attachment is also thrown into engagement in order to control the lead of the screw.

Advantages of Accurate Gages

By L. K. Goss

The fact that precision gages and accurate tools make it easier for the workman to get his work past inspection, seems worthy of more attention and wider acceptance. Whether the tolerances on the product are close or wide, proper tools produce work within the limits more easily and proper gages show a greater proportion of the work as being within the sizes specified.

Consider for example the case of a 0.500-in. hole reamed to limits of minus 0.0000, plus 0.0005 in., using double-end-limit, plain plug-gages to inspect the size. If gages accurate within the usual limits of 0.0001 in. are used, the GO gage will measure close to 0.5001 in. and the NO GO gage will measure close to 0.5004 in. The gages will accept only those holes that fall between 0.5001 in. and 0.5004 in., so that the workman is actually compelled to hold the sizes within 0.0003 in. instead of 0.0005 inch.

If on the other hand gages made to closer tolerances are used, a GO gage can be secured to measure 0.500025 in. and the NO GO gage 0.500475 in. they will give the workman 0.00045 in. in which to work—an increase of 50 per cent. Another advantage of using close-limit gages is that they are generally produced by machine lapping and this process gives a wearing surface having a much longer life than that of a hand-lapped gage.

An example of accurate tools making the work easier, is the case of ground taps. All taps cut larger than their measured sizes, the amount depending to a great extent upon the run-out of the machine. Ground taps can be secured at reasonable prices that measure between the correct basic pitch-diameter and not more than 0.0005 in. larger, whereas the so-called "commercial taps" measure several thousandths larger than the basic pitch-diameter. It is clear that the machine run-out requires more care and effort from the operator who is using oversize "commercial taps" than when he is supplied with ground taps made close to basic pitch-diameter.

These examples could easily be continued but those given suffice to show that accurate tools and precision gages work hand-in-hand to make production easier for the operator and to prevent scrapping pieces which are actually within limits. The operator who used to say his work was not close enough to require precision tools and gages, is learning that they are a real advantage to him, even on work made to comparatively wide limits.

"State Salary Wanted in First Letter"

By Entropy

When reading the advertising columns of trade papers or dailies, we see this statement over and over again; but how can anyone say just what salary he will accept without knowing more about a job than he can get from a three- or four-line advertisement? Does the advertiser mean to imply that all he has to offer the applicant is expressed in the pay envelope? Is there not hope of advancement, comfort in work, availability of housing, schools for children?

And if there are some of these other and valuable rewards to be given are not they worth mentioning in the advertisement, even if it does cost a few cents to put them in?

We all know of men who have gone from jobs which paid well to those at five hundred or a thousand less, because they felt the need of going where their children could get proper schooling, or where their sons could secure suitable jobs for themselves. We all know of men who have taken smaller pay in another shop rather than work under a tyrannical foreman. Why not cash in on these advantages, if they exist?

There is no market rate for men above the grade of laborer, and there ought not to be, except in shops or factories where work is treated as a commodity, to be bought at the lowest rate and exploited if possible. These advertisements, however, are not by any means confined to such places. They come more as a habit of thought than as an expression of meaning. Can any shop afford to let the men whom it needs to hire think that it regards them only in terms of dollars and cents?

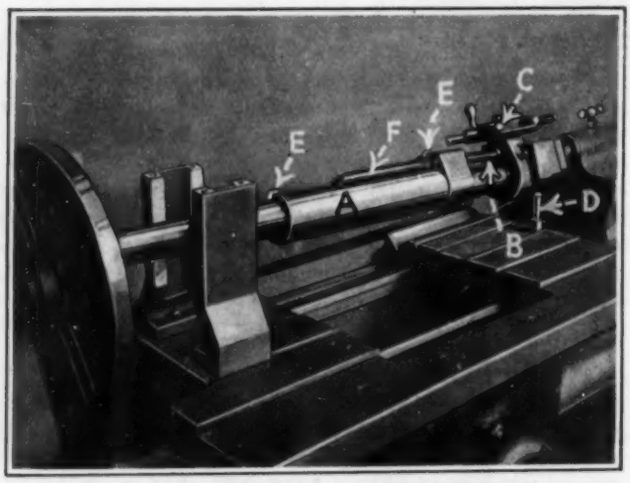
Ideas from Practical Men

Devoted to the exchange of information on useful methods. Its scope includes all divisions of the machine building industry, from drafting room to shipping platform. The articles are made up from letters submitted from all over the world. Descriptions of methods or devices that have proved their value are carefully considered, and those published are paid for

A Compact Boring-Bar for Taper Holes

By JACK WILLIAMS

The illustration shows a bar used for boring the holes in the wheel-head to take the tapered adjustable bearings of the main spindle of the Fraser automatic cylindrical-grinder, built by the Arter Grinding Machine Co. of Worcester, Mass. There are two holes in exact alignment and of the same degree of taper, but of different mean diameters. The bar was designed



A compact taper-boring bar

by Mr. Fraser and, though constructed upon principles as old as the art of taper boring, embodies some features that are worthy of notice.

The bar is here shown in a lathe that has been fitted with a special carriage to accommodate boring jobs, but it may, of course, be used in any machine that is provided with a pair of centers and means of securing the work.

The degree of taper that can be bored is determined by the amount of offset given to the centers of the bar itself, and in this tool cannot be adjusted; though a more universal tool of the same general design can easily be contrived by making one or both centers in separate pieces that are capable of adjustment crosswise of the bar.

The tool carrier *A*, is a steel sleeve fitted to the bar so that it may slide endwise thereon, and is splined to it. This method of mounting the tool carrier provides a long and substantial bearing, well suited to support the tools while cutting, and insures against chatter or variation of diameters due to springing of the parts.

Endwise movement of the sleeve for feeding the tools to the cut is caused by the square-thread screw *B*, which is threaded through the projecting lug at the end of the sleeve and is turned intermittently by small bevel gears and the "star wheel" *C* at the end of the bar.

The star wheel is a cast-iron disk provided on its face with a small handle to facilitate setting the tools and for rapid withdrawal at the end of a cut. Radially projecting pins upon the periphery of the disk engage the fixed stop-pin *D*, attached to any stationary part of the machine that is convenient. In this tool there are eight of the radial pins and the bevel gears are 1-to-1 ratio, so that the screw is given a one-eighth turn at every revolution of the bar. The star wheel is splined to its stud and confined by a washer and nut, so that it is easily interchangeable with wheels having different numbers of pins to provide various feeds.

The cutting tools *EE* are set into tapered dovetailed slots, one in the near end of the sleeve and the other in the projecting lug. These slots are parallel with the axis of the bar. Tapered keys, or wedges, hold the tools in position. The cutting tools may be set out to compensate for wear and regrinding by placing thin shims under them before driving the wedges, but it will be observed that the actual radial setting is immaterial; it is necessary only that the *relative* setting of the two tools be maintained. The diameters of the holes bored by the tools in any setting may be regulated quite easily by a slight traverse of the lathe carriage.

The relative setting of the tools is easily measurable by passing a micrometer over the point of the tool and the opposite side of the sleeve. One measurement must be so many thousandths more or less than the other; within reasonable limits it does not matter what the actual distance may be.

Despite the appearance of angularity, due to the offset relation of the centers, there are no tapers, inclines or other awkward details of construction about the bar. It is practically all straight lathe work except for a few shaper jobs, such as splining the bar and sleeve and making the dovetailed slots to hold the tools. The part *F* is merely a sheet metal cover to protect the screw from chips, and was soldered to the sleeve after experience had shown that the chips were likely to cause trouble. The screw itself is parallel with the bar.

The designer of this tool makes no claim for its versatility—for his purpose it is strictly a production tool—but the observant reader will readily see that with a few minor changes it may be made adaptable to quite a wide range of work. Its chief feature is its rigidity in comparison with its small size. The principal trouble with the taper boring bar as commonly made, is that it is difficult to secure compactness and freedom from chatter in the same tool, for which reason almost all such bars are comparatively large.

A Shop Rig for Drilling Deep Holes

By William Denton

The job of drilling a hole lengthwise through a piece of round stock three feet or so in length and having it come out somewhere near the center of the bar at the other end, is not regarded as specially difficult in a rifle shop where it is but a small part of the day's work, but given to the average mechanic in a shop where such work is not regularly done and it is likely to cause him no little amount of consternation. I can well remember when in my own apprentice days I was given such a job, my fellow-workmen gathered round my lathe and pretended to discover where the drill was breaking through the side of the bar about half-way up, scaring me half to death and causing me to try all sorts of suggested remedies to save the job before the boss found it out.

The illustration Fig. 1 shows a rig employed for the purpose in a shop where there are a large number of such pieces to be drilled, ranging in length from

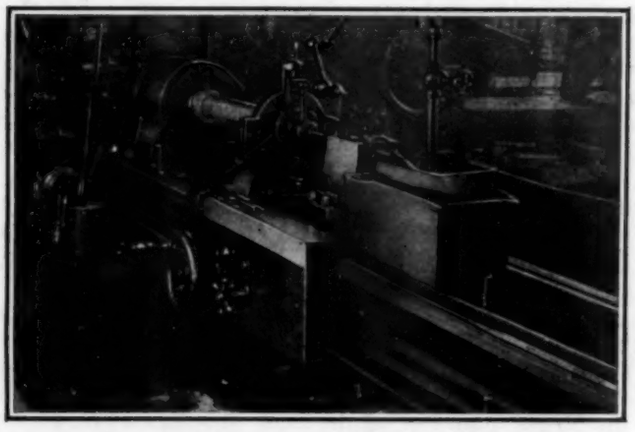


Fig. 1—Set-up for drilling deep holes

eighteen or twenty inches to three or more feet. The machine used is a standard engine lathe with an extra long bed. No special devices are used except the drills, a special toolholder on the carriage and the machinery for supplying the oil circulation.

Before coming to the drilling operation the pieces have been centered, faced, and some of them rough-turned, or at least a bearing spot turned near one end for the steadyrest jaws. The piece is "swung up" in the lathe in the usual manner with one end gripped in a universal chuck and the other carried in the steadyrest.

The shape of the special toolholder may be seen in the illustration. It is gibbed to the bridge, but has no nut for the cross-screw as there is no need for cross adjustment. It is fixed in central position by tightening the gib screws and is bored in alignment with the centers of the lathe. The upper part is made just like an ordinary two-piece bearing and holds any size of round shank up to its capacity by means of split or halved bushings.

Two kinds of drills are used, according to the diameter and depth of the hole to be drilled. The smaller ones have a single straight flute extending the whole length of the drill and shank, cutting away something less than a quarter of the circumference. A deep groove is milled lengthwise of the drill opposite to the flute, the upper part of the groove being wider than the remainder and undercut, or dovetailed, to receive a flat strip of steel which is fitted to the dovetail, driven in and peened or brazed in place, and the drill ground to size. This strip covers the groove and forms a hidden oil channel from end to end of the drill.

Drills of this kind are made of different lengths as well as diameters, and they are used in sequence, a short drill being used to start the hole, succeeded by longer and still longer ones until the final drill completes the work. A flexible tube is coupled to the butt of the drill and the oil passes through the concealed channel to the cutting lips, returning through the flute and carrying the chips with it. The flute of the drill being straight the cutting lip has no rake, and the end is "stepped," both conditions being necessary to prevent the formation of large or curled chips that would not wash out with the oil.

The other type of drill, an example of which is shown in Fig. 2, is used for holes of larger diameter and greater depth. These drills are quite short and are used in connection with tubular shanks into which the drills are screwed. They may have two, three or four flutes, according to their diameter, and though the flutes are helical to a slight degree the cutting lips are ground back about ¼ in. to present the same rake angle—or absence of rake angle—to the cut as does the lip of the single-flute drill. The lips also are stepped, as before described, and for the same reason.

These drills are hollow for a part of their length, the axial hole terminating in a chamber that provides passage for the oil through two of the flutes, as can be seen in the illustration. The tubular shank is smaller in diameter than the drill, leaving an annular space between the tube and the wall of the drilled hole for passage of the oil. Oil is delivered through this annular space and through the flutes not connected with the central chamber to the lips of the drill and returns, with the chips, through the central hole and hollow shank. In the set-up shown by Fig. 1 one of these drills is at work and the stream of oil may be seen issuing from the end of the tubular shank.

To get the oil to the lips of the drill around the outside of the shank a stuffing box and gland are

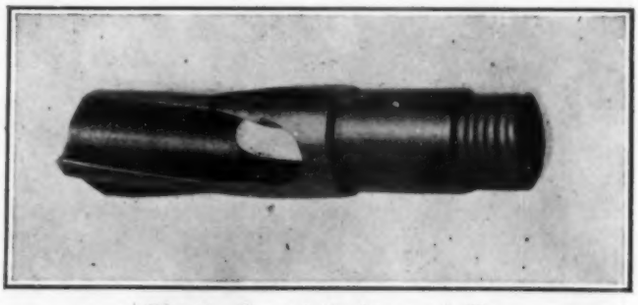


Fig. 2—One of the larger drills

necessary. The stuffing box is a chambered casting bolted to the jaws of the steadyrest and abutting against the revolving end of the work. A fiber washer is interposed between the metal surfaces to reduce friction to a minimum. The tubular shank passes through the stuffing box and is packed to prevent the escape of oil in a rearward direction. Oil is delivered through a pipe connecting directly with the chamber of the stuffing box.

This type of drill provides greater freedom for the passage of the chips than does the straight-flute drill,

but owing to its construction it cannot be made sufficiently strong in the smaller sizes to withstand the torsional strain. Oil is delivered under pressure to both types of drill by means of a triplex-piston pump, which can be depended upon to maintain a fairly steady discharge without resorting to a compensator.

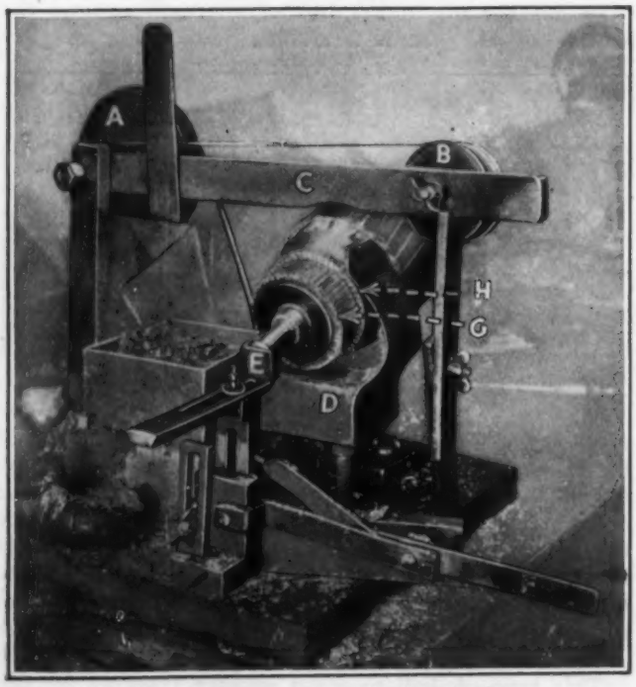
There is never any trouble from "running" of the drill except in the case of a non-homogeneous forging, which would be rejected anyway for structural reasons. If ordinary care is exercised to start the hole centrally while the end of the work is still exposed, it may be expected to remain reasonably central at the other end. The holes do not go clear through the forging, as the opening at the other end has to be an accurately formed and centrally disposed taper, and is made by boring and reaming from that end in the usual manner.

A Device for Soldering Commutator Leads of Small Motors

By Henry Densmore

The device shown in the accompanying illustration is for the purpose of soldering the leads from the windings of small-motor armatures to the commutator bars, replacing a hand operation that required a great deal more time to accomplish and producing far more satisfactory results. Two of the devices are attended by one operator, and they are so nearly automatic in their operation that about all he has to do is to load and unload them and to apply a flux to the desired point as he puts each into action.

The armature to be soldered rests in an inclined position upon two open bearings in which it revolves upon its own journals. One bearing, though adjustable in two directions to accommodate different sizes of armatures, remains fixed when once set for each size until the soldering is completed upon the lot. The other bearing, which may be raised or lowered by means of a lever, is provided with a latch to hold it in its upper position and an adjustable stop to regulate its lower position, thereby determining the depth to which the work is immersed in the molten solder.



A semi-automatic soldering device

A small motor drives the pulley *A* by means of a round belt. In one piece with this pulley is a smaller, flat-faced pulley from which a belt about ½-in. wide runs to the idler *B*, which is adjustable lengthwise of the lever *C*, to maintain the tension of the belt. Lever *C* swings about the center on which the pulley *A* revolves and may be raised to a vertical position (for loading the work) without disturbing the tension of the belt. A rectangular trough *D* is filled with solder, which is kept in a molten state by a gas flame beneath it.

The bearings in which the armature revolves are so adjusted that when the armature is placed therein and the bearing *E* lowered to its stop by raising the lever *F*, the corners of the commutator bars at *G*, pass through the molten solder as the armature revolves.

With the lever *C* standing upright and the bearing *E* latched in its upper position, an armature is placed in the bearings, the commutator at *G* just clearing the surface of the solder. The lever *C* is then lowered to a horizontal position, bringing the flat belt across the upper portion of the periphery of the armature and setting it in motion. The speed at which the armature revolves has a good deal to do with the success of the operation, and is adjustable at the driving motor.

The armature picks up speed almost immediately. The operator then uses a small brush to apply a semi-liquid flux to the shoulder at *H*, where all the leads to be soldered are located, and at the same time lowers the bearing *E* by means of the lever *F* until the extreme corner of the shoulder at *G* dips in the solder.

The action of the solder is peculiar. The parts to be soldered do not dip in the solder at all—only the opposite ends of the segments—yet the molten solder flows over the length of the commutator and out to the largest diameter of the inner shoulder at *H*, where it accumulates and seals the leads in a most satisfactory manner.

A part of the action is, of course, due to centrifugal force, as the molten solder flows from a smaller to a larger diameter for the same reason that water flies off a grindstone; but some other explanation is necessary to account for its flow up-hill over the parallel part of the commutator.

The flow of solder is almost instantaneous, and the operator does not leave the commutator in contact with the molten metal for more than ten or fifteen seconds. He then raises bearing *E* to its upper position, wipes off the surplus solder by applying a cloth to the revolving commutator, and allows the armature to revolve while he attends to the other device, so that the solder may set. Not only is this method much faster than soldering the leads individually by means of blow-pipe and flame or soldering copper, but it can be done by anyone without danger of breaking the delicate leads or burning the insulation from the wires.

No solder is wanted on any part of the commutator except at the place where the leads are joined to the bars, and very little remains elsewhere. Though the commutator is covered by a film of solder while the corner is in contact with the molten mass, this film disappears from all parts except where the flux has been applied as soon as the armature is lifted. The commutator is turned and faced in a succeeding operation anyway, removing the last vestige of solder.

Technical Abstracts

Strength of Cast Iron and Its Thickness

The purpose of this investigation by Willard Rother of the Buffalo Foundry & Machine Co. is to determine the relation between the physical characteristics of cast iron and the thickness of castings for the guidance of the designing engineer and the protection of manufacturers. The article is well illustrated and descriptive of the tests that were made by increasing the thickness of a casting. There is considerable discussion on the ultimate strength expressed as pounds per sq.in., cross sectional area. The controlling factor governing the strength of cast iron is the presence of graphitic carbon in the free state. It is well known that the proportion of free and combined carbon varies with the thickness of a casting. A thin casting cools quickly and allows a considerable portion of the carbon to remain in the combined state, which gives a close grained iron. The same iron poured in a heavier section cools more slowly, permitting increasing quantities of carbon to change from the combined to the free state.

The concluding part of the paper states that more research is needed before a definite relationship can be established for use in engineering calculations.—*The Iron Age*, August 7, 1924, p. 326.

Automatic Milling

Franklin D. Jones states that in determining what equipment and methods to employ for milling duplicate parts, there are three points that a competent milling machine engineer considers very carefully. One pertains to the working or cutting period; the second has to do with the method of holding and presenting the work to the cutters; and the third relates to non-cutting time which may be necessary, it being generally conceded that "air cuts" are non-productive. Samples are given which illustrate the importance of these different points and show interesting variations in methods of milling different classes of work.

The milling machines used are the Brown & Sharpe automatic types, No. 21 and No. 33. Their operation is controlled automatically, although the loading and unloading of the work is done by hand. The automatic control includes both table and spindle and the table can be given a variable cutting feed in either direction. An example of multiple slot milling is given, and is interesting because of the method of handling the work and the high rate of production attained. This shows the slotting of the ends of malleable knife handle castings. Three slotting cutters are used and these are located between two sets of fixtures, each of which holds six handles. The cutters rotate and the table reciprocates continuously, the reversal of the table taking place at a rapid rate.

In another example of plain slot milling illustrated a gang of four high speed steel slotting cutters is located between two fixtures, the cutters reciprocating from one fixture to the other, a rapid travel taking place during most of the time slowing down only just at the point of reaching the work. The number of cuts per hour is 133, and as four castings are milled simultaneously the hourly production is 532 pieces.

In milling parts by this method, the cutting time must exceed the fixture-loading time slightly, and this factor helps to determine the maximum number of parts that can be milled simultaneously. In some cases the rate of feed is reduced somewhat in order to lengthen the cutting time sufficiently to provide a long enough period for loading the fixtures.

Similarly other work, such as straddle-milling, the use of right- and left-hand cutters, the use of duplex cutter-spindle attachment, are illustrated and described.—*Machinery*, August, 1924, p. 919.

Bearing Metal Has Heat Limits

An interesting article by J. J. Curoe of the Westinghouse E. & M. Co. states that in standard babbitting practice the mandrels are preheated to 100-250 deg. C. and bearing shells to 100-250 deg. C. When the shells are not preheated the bearing metal cools very rapidly and in consequence shrinks away from the containing shell, causing it to be loose therein. Solidity of the shell lining and tightness in the base are considered more important factors than hardness of the metal, as without them there will be trouble from loose linings.

Babbitt metal should never be heated beyond 490 deg. C. (914 deg. F.) and the mandrels and bearing stells should be preheated to definite temperatures, so as to permit the shell and babbitt to shrink together. The correct procedure is to maintain the pouring temperature within the range 460-482 deg. C. (860-900 deg. F.) and keep the hardness within certain fixed limits.

It is very important that bearing metals be kept within certain definite temperature limits, as experience has shown that good bearing metals can be rendered worthless by allowing them to rise to too high a temperature and also by pouring them either too hot or too cold.—*Automotive Industries*, July 24, 1924, p. 211.

The Best Working Conditions for Metal Drills

N. Sawine, Professor at the Technological Institute of Zagreb, Jugo-Slavia, discusses quite thoroughly the various elements affecting the forces exerted on a drill, and gives what he considers the best cutting angles, helix angle of fluting, etc. He points out the serious effect of the flat point of the tool on the axial pressure and recommends notching the point. This reduces the axial force, especially for drilling in steel, although somewhat less for cast-iron. It also prevents the crumbling of the cutting edges. Pre-drilling is recommended for all large holes, because it reduces the axial pressure from 50 to 60 per cent for iron and steel and somewhat more for cast-iron. An included angle between the cutting edges of 116 deg., a clearance angle of 6 deg. and a cutting angle of 60 deg. are recommended. The angle of the helix with the axis is set at 30 deg. and doubt is expressed whether the smaller angle used by some designers is as good.

Diagrams are presented showing the distribution of the vertical pressure over the cutting edge for experiments, and formulas for this pressure and for the turning moments are derived on the basis of empirical constants for drilling resistance and materials.

The author points out that more exact holes can be produced in lathes and boring machines than in drills and emphasizes that for exact work in drills special jigs or tool steering arrangements are necessary.—*LeGenie Civil*, July 26, 1924, p. 91.

Thermit Bearing Metal

This bearing metal developed by Th. Goldschmidt, A. E. G., in Essen, Germany, is evidently a lead-base metal, hardened by nickel and certain other patented ingredients. It has been developed to avoid the use of tin. Tests at the Technological Institute of Charlottenburg, at the Laboratoire d'Essais, Paris, and the National Physical Laboratory at Teddington, Eng., have uniformly demonstrated that the new allow stands up better under poor lubrication than tin alloys, and that it maintains its Brinell hardness better at increased temperature. It can also be re-cast a number of times without losing its properties. Nothing is said about its friction qualities, but nowa-days we understand that at least for high-speed conditions the bearing material is comparatively unimportant in this respect, the lubricant determining the friction. The new metal is therefore considered a complete solution of the problem of replacing a tin-base by a lead-base metal.—*Deutsche Motor-Zeitschrift*, July 5, p. 97.

American Machinist
Established 1877
KENNETH H. CONDIT AND FRED H. COLVIN, *Editors*

Credit for the World Flight

THE country is ringing with acclaim for the daring men who have circled the globe in airplanes. We join in honoring their skill and courage. They have won through over severe obstacles, not the least of which have been the nerve-testing delays for favorable weather.

It should not be forgotten, however, and the pilots themselves will be the first to remember it, that the success of the trip would have been almost impossible without the work of the men behind the scenes. We have heard something of the devotion of the naval patrol ships and their crews. But little has been said of the careful planning and attention to detail that provided the kits of emergency tools, the supplies of spare parts and their presence at strategic points. Tribute should also be paid to the designers and constructors of the planes that made the trip. As an endurance test of the materials and workmanship employed in their construction, the World Flight with its extremes of heat and cold, of dryness and dampness, has been thorough to say the least.

There is no intention on our part to minimize the glory of the achievement of the men who actually made the trip. Our only thought is to give a measure of the credit due those other men in the shops and elsewhere whose work had much to do with the success of this journey as against the failures of MacLaren, the Englishman, and Locatelli, the Italian, each of whom had to play practically a lone hand.

Better Agricultural Equipment Will Be Needed

WITH the development of any particular business or industry there is a constant tendency to more precise methods and better tools and equipment. The agricultural implement business is no exception, for it is beginning to foresee a similar demand in its field. It is perhaps too early to anticipate gaining some of the business now carried out in a crude fashion; but the time will come when agricultural implements will be more than assemblies of unmachined parts.

The use of more concentrated fertilizer materials direct on the farm is one of the factors that will enter to speed this day. The need of better mechanical equipment will be obvious when the farmer undertakes to distribute fertilizers containing 30 per cent, 40 per cent and 50 per cent plant food instead of those which have commonly been used in the past containing only 8 per cent to 15 per cent of the valuable plant food constituents. With the more concentrated fertilizers will come some increase in the quantity of plant food used per acre, but this will not be sufficient wholly to compensate for the greater concentration in the material. Hence, instead of 400 lb. per acre the farmer will wish to distribute 100 lb., or in some cases even a smaller quantity. This will, of course, necessitate that the distributing equipment be so well designed and so smooth in operation as to give practically a uniform spread over the entire area treated.

This is but one of the many industrial trends which demand a higher quality of machine construction. It is but one of the evidences that the skilled machinist of the future will be called upon to build and assemble devices that are today only assemblies of rough castings, forgings, or roughly finished parts.

Buying With Cheap Money

UNLESS one doubts the future of his own business it is a sound policy to prepare for reducing costs by buying new equipment at low prices. And we should remember that actual prices depend as much on the cost of money as on the cost of the machines bought. The low cost of money at present makes it advisable to buy the equipment that may be needed to put the plant in a position to compete for new business.

Too many shops cling to an old machine just because it will still run and frequently boast that it was written off the books years ago. Some seem to think they are putting one over on the tax collector by this method but the joke is on them as they are cheating themselves out of low-cost production by keeping the old tools in the shop.

If some kind hearted burglar would back up a freight train with a wrecking crane, and sneak off with every machine over ten years old, the owner would owe him a vote of thanks.

To those who appreciate the advantage as well as the necessity of modern equipment, the present low cost of money should present an opportunity for improving their plants.

Just Suppose

JUST suppose that some large machine shop had among its assets about $10,000 worth of tool steel, rolled before Messrs. Taylor and White made their bow to the public. And suppose the manager told the superintendent that this old steel must be used up before any high-speed steel would be bought. And suppose he insisted upon his orders even after the superintendent explained that the steel had been bought cheap, and that it had been written off the books anyhow so that it really wasn't costing anything. What would be your private opinion of that manager?

Now suppose that the same shop had a lot of old-fashioned machine tools and other equipment which was in good running order and really was not costing anything because it had been written off years ago, and suppose the manager told the super that this high-grade junk must be used until it became low-grade junk before he would allow new and up-to-date machinery to be bought. What would be your private opinion of *that* manager?

Well, you say, but nobody would think nowadays of using ordinary tool steel if———

All right, but

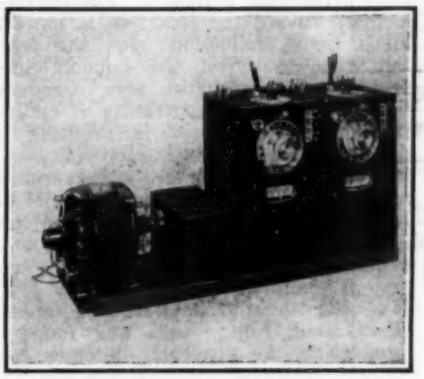
Just suppose.

Shop Equipment News

Wilson-Maeulen Automatic Temperature Controller

A recent product of the Wilson-Maeulen Co., Inc., 383 Concord Ave., New York, N. Y., is an automatic temperature controller designed for use on oil, gas, electric, or steam-heated furnaces. The device will operate with standard power valves of the motor-driven, solenoid, or hydraulic type.

The complete machine consists of three standard interchangeable units.



Wilson-Maeulen Automatic Temperature Controller

Power is furnished by a ¼-hp. motor of commercial size and design, and is transmitted to the control unit through a train of gearing running in oil. The potentiometer method is used in the control unit and the apparatus is actuated by a thermocouple circuit using either base-metal or noble-metal thermocouples. The galvanometer and all mechanical parts are standard and interchangeable.

Close and accurate setting for temperature is accomplished by 12-in. dial. The unit feature of the equipment makes it possible to provide multiple control capacity by adding control units to the same power unit. These units to the number of six can be added or removed without disturbing the balance of the equipment.

The standard cycle of operation is ten seconds but units can be supplied for cycles of five, ten, or twenty seconds. The period of contact may be specified from one to seven seconds to suit the requirements of various types of power valves. A wide variety of temperature ranges are furnished for many kinds of thermocouples.

Weaver Model F Universal Axle Stand

For supporting automobile rear axles of various types during disassembling for repairs and similar operations, the Weaver Manufacturing Co., Springfield, Ill., is now marketing its Model F universal axle stand. The device is designed to hold solid as well as split axles.

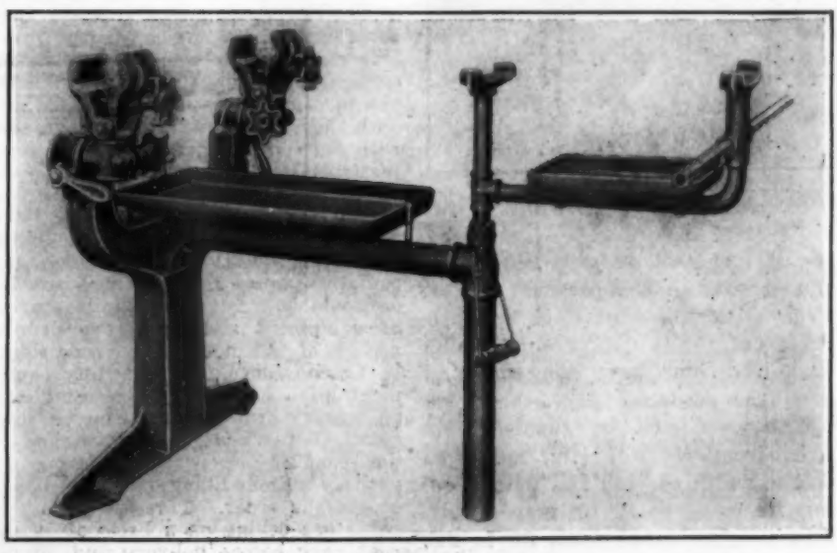
The jaws at the left-hand end of the stand in the accompanying illustration are universally adjustable and will hold the work in the most convenient position for performing the work that is to be done. The opening of the jaws is sufficiently large to accommodate axle and drive-shaft housings, the entire housing being held by both jaws, or one section of a spit housing being held independently in one clamp.

The large oil pan is big enough to hold the grease from the differential and can be readily removed for emptying. The supports at the right-hand end of the stand are provided for the drive shaft and are adjustable for height and angle. A tool tray is located between these supports and the arm on which it is fastened can be rotated into the most convenient position. This arm also carries a transverse rod for supporting radius rods. The base of the stand is made sufficiently wide and heavy to support the work without tipping, but the entire device is light enough to be conveniently portable.

Noble & Westbrook Automatic Numbering and Marking Device

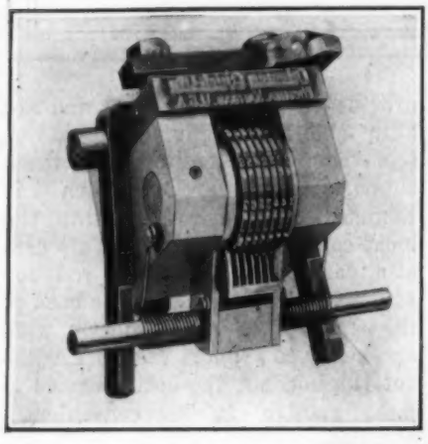
A recent addition to the numbering machinery manufactured by the Noble & Westbrook Manufacturing Co., Hartford, Conn., is the automatic numbering and marking device shown in the accompanying illustration. This machine is designed for use in numbering cylindrical parts and will, in addition, mark names, trademarks, etc., on these parts at the same operation.

The parts to be numbered are carried on a suitable holding fixture on the table of the marking machine to which the device is attached, and are automatically rotated into position. For ordinary changing of the



Weaver Model F Universal Axle Stand

numbers a hand lever can be depressed to give the next higher number. The device illustrated is furnished with a lever that strikes a fixed point on the holding fixture and automatically advances the number-

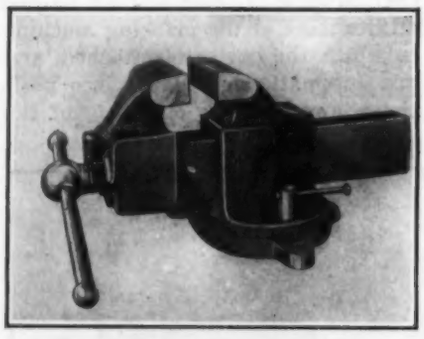


Noble & Westbrook Automatic Numbering and Marking Device

ing dies to the next number. This arrangement makes the device adaptable for the serial numbering of a variety of cylindrical parts.

"Simplex Gray" Swivel-Base Vise

The Simplex Tool Co., Woonsocket, R. I., is now prepared to furnish its entire line of vises with swivel bases. The slides of these vises are of steel and the bodies are of a toughened grade of crucible iron. The jaws



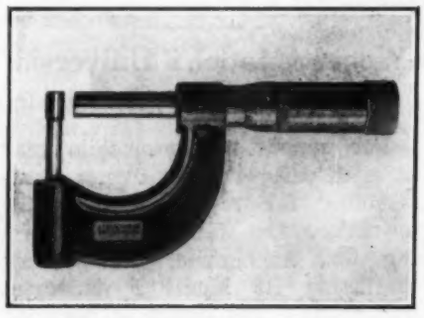
"Simplex Gray" Swivel-Base Vise

are of tool-steel, serrated, hardened and ground. The screws are of steel, with the square thread machine cut. The nuts are of malleable iron and have long bearing upon the screws.

The vises can be furnished in sizes from 3½ to 7½ in., measured on the width of jaw, and with openings from 4½ to 12 in. respectively. The weights range from 35 to 210 pounds.

Slocomb Tube Micrometer

The J. T. Slocomb Co., Providence, R. I., has placed on the market a micrometer especially adapted to measure the wall-thickness of tubes. The tool is of standard construction throughout, except that the frame is designed to support a stud extending at a right angle to the measuring spindle and forming the anvil. The diameter of the stud limits the internal diameter of a tube that can be measured. The tools are made with studs of various sizes, so that



Slocomb Tube Micrometer

one can be chosen to suit the work in hand. The minimum internal diameter that can be accommodated by the tool is ⅜ inch.

The micrometer is so adjusted that when the end of the measuring spindle contacts with the stud the reading will be zero. Therefore, when a tube or other piece of work having one concave surface is placed over the stud, the thickness of wall is shown directly by the graduation of the thimble.

How Russia Is Buying Its Machinery

An investigation into the conditions of electrical development in Russia may be of interest as indicating the probable situation in other lines. The investigation was made, not in Russia, but in countries selling to Russia, and with men who are fully conversant with Russian affairs today—who have just come out and are just going back.

Russia is building some electrical plants and some transmission lines. She is trying to rehabilitate her industries. The question is where does her equipment come from. It was possible to locate at least four definite sources of equipment and there are definite reports of two more. The Skoda works in Czecho Slovakia are selling equipment on a basis of 15 per cent cash on signing order, 15 per cent on shipment, 15 per cent on erection and 55 per cent in seven years—terms not entirely to their liking, but near enough to get the order. Three English concerns are selling on a basis of 50 per cent cash before delivery and 50 per cent in about five years.

Metallurgy Thrives in Luxembourg

The Luxembourg Chamber of Commerce gives the following details on the state of metallurgy in the Grand Duchy since the treaty of Versailles. Article 268 of that document made possible the final manipulation of iron and steel within the country, the producer coming thus nearer and nearer to the consumer where under the former Zollverein raw and semi-raw products were largely shipped to German transformers. An economic union was established with Belgium replacing the former German-Luxembourg working combination.

The industry has suffered from a penury of labor and the eight-hour law which has been applied with all possible strictness. Luxembourg labor is more and more emigrating to France.

Fear the Dawes Plan

The general situation is undergoing progressive amelioration from day to day and, were it not for the foregoing conclusions, the industry would be far more prosperous than it is. For the immediate future the situation is not at all brilliant, following upon the fear that the results of the London conference will actually give German metallurgists the opportunity of entering world markets with its products to the detriment of other European exporting nations. Luxembourg is essentially an exporting country for its metallurgical output considering that its 1923 production of pig iron was 1,406,666 tons for a population of but a quarter of a million souls and an area of less than a thousand square miles. With steel, rolling mill and foundry production the situation becomes the more accentuated.

The comparison of the pig iron and steel production of Belgium and Luxembourg during 1923 is significant. Each is perforce an exporting country to an extent hardly applicable to any other of Europe. Belgium on one hand is practically its own furnisher of metallurgic coke while Luxembourg is largely dependent on foreign sources of supply.

	Belgium (tons)	Luxembourg (tons)
1923 pig iron production	2,188,130	1,496,666
1923 steel production	2,216,650	1,193,471

Blast furnaces in operation in Luxembourg numbered 47 in 1923, employing 4,181 workmen and consuming 3,403,079 metric tons of Luxembourg mineral and 929,434 tons from abroad.

Steel plants numbered 7, employing 1,898 workmen. There were produced 1,193,471 metric tons of ingot steel at an average selling price of 486.30 francs per ton. Electric steel was produced to the extent of 7,713 tons.

Rolling mills numbered 6, with 3,708 workmen. Semi-finished and finished products amounted to 1,511,504 tons of which the biggest items were bars and small profiles to the extent of 339,333 tons. Machine wire was produced to the extent of 83,300 tons.

Foundrys numbered 11 with 928 workmen, using 13,556 tons of semi-raw material, and 13,262 tons of scrap.

News of the Week

Mobilizing Industry Forms Important Part of Defense Day Program

Judge Gary and advisory board meet in New York City

Under instruction of the War Department and the Chief of Ordnance, the New York ordnance district, under command of Col. James L. Walsh, began a rehearsal of the administration action necessary to organize the district into an effective agency for the production of ordnance in case an emergency should arise. As soon as the administrative machinery for this expanded office was in motion the Advisory Board was informed, through its chairman, Judge Gary, and the advice of the Board was sought on questions of general policy, such as power supply, construction facilities, transportation, war credits, dilution of labor and other problems.

Meetings of Division chiefs and reserve officers were held daily, at times not to interfere with business, until Friday, Sept. 12, when the District Office moved to the Engineering Building, on 39th St., New York, and held all day sessions. The meetings included "Engineering and Increased Facilities," "Small Arms," "Aircraft Armament," "Ammunition, Artillery," "Tanks and Trailers."

Industry's Part

The objects of the meetings were explained by Judge Gary, Col. Walsh, Gen. Bullard and Gen. Guy E. Tripp, whose experience in Washington during the war led to the de-centralization of the offices for securing munitions and the establishment of twelve district offices through which all business from that district could be transacted. The present plan is the outgrowth of this plan, and will enable the army and navy to secure material much more satisfactorily and with much less delay than through a central office in Washington. It is the intention to have each office maintain a close contact with all the manufacturing facilities in its district so as to know who to call on for supplies of any kind, in the shortest possible time. This can only be developed to its fullest extent by complete cooperation of manufacturers and will take time to accomplish.

Judge Gary presided at the get-together meeting and, after reading telegrams of congratulations from President Coolidge and Gen. C. C. Williams, Chief of Ordnance, pointed out the economy to be secured by avoiding delays and excessive cost for materials. Col. Walsh was given great credit for his work in organizing the New York district so effectively and for the way in which he had handled the mobilization meetings.

Col. Walsh pointed out the necessity for educating both the officer personnel and the manufacturers as to the needs of the government. The officer must know his job and its limitations and co-operate with the manufacturers in every way. The difficulty in 1917 was that no one seemed sure of what to make and the delays in getting started were costly. Arms and munitions require a much longer time to produce than to train men so that material is all important. And when war was costing us $1,000,000 an hour the expense of delays can be readily seen.

Important War Factors

Gen. Bullard stated that the engineers and industrialists were the most important factors in the war and seemed to know what they were doing. As a result of his experience of over 40 years in the service he felt that any reasonable plan put into action was far better than waiting for perfection in any particular line. He was much pleased with the co-operation of the manufacturers and had never known such close harmony as now existed.

Gen. Tripp, after outlining some of the problems of the last war, pledged the industrialists to the service of the army and said that this was the first time they had ever been notified in advance what was expected of them.

There was a reproduction of the district office in the Engineering Building so that all could see exactly how matters were handled and get a good idea of the problems involved in maintaining such an organization.

Convention of Railway General Foremen

That the eighteenth annual convention of the International Railway General Foremen's Association, held at the Hotel Sherman, Chicago, Sept. 9, 10, 11 and 12, was productive of results that should be reflected in more efficient shop management, seemed to be the consensus of opinion among those present. The convention was called to order Tuesday morning by President Geo. H. Logan, and invocation was asked by Rev. W. A. Rowell of Chicago. Mayor Dever of Chicago delivered an address of welcome, which was responded to by F. M. A'Hearn. President Logan also delivered an address.

Wednesday morning the convention was addressed by H. T. Bentley, general superintendent, M. P. & M., C. & N. W. Ry., which was responded to by J. N. Chapman, district foreman, Illinois Central Ry. The various subjects, as chosen by the executive committee, were assigned to committees who prepared papers on the topics assigned and which were taken up in the following order: "Steel Car Repair Facilities and Methods of Repairs to Various Parts of All Classes of Steel Cars"; "Labor Saving Devices Other Than Those Sold or Patented"; "Terminal Inspection, Running Repair Costs and Repair Work Practices"; "Maintenance of Superheaters"; "Feed-Water Heaters"; "Locomotive Stokers and Locomotive Boosters." The convention was thrown open for discussion after the reading of each paper.

Officers Elected

The following officers were elected for the ensuing year: President, H. E. Warner, N. Y. Central R.R.; first vice-president, C. A. Barnes, Belt Ry. of Chicago; second vice-president, F. M. A'Hearn, B. & L. E. R.R.; third vice-president, F. M. Lauer, Illinois Central R.R.; fourth vice-president, C. F. Baumann, Chicago & Northwestern R.R.; secretary-treasurer, Wm. Hall, Chicago & Northwestern R.R.; members of executive committee; M. R. Benson, chairman, Wm. Mulcahy, J. H. Armstrong, H. Saunderson and B. L. Davies.

The total registration of general foremen was 119 and there were 69 exhibits by the Association of Railway Supply Men. A reception and cotillon was held at the Hotel Sherman Tuesday evening, and Wednesday evening the entire convention formed a theater party. An informal dance was held Thursday evening.

Fitchburg Works Merges with Seneca Falls

The Fitchburg Machine Works, of Fitchburg, Mass., has consolidated with the Seneca Falls Machine Co., Seneca Falls, N. Y.

The Fitchburg concern will move to Seneca Falls, completing the transfer about the first of the year. The plan to make the merger has been under consideration by the company for some time, according to Marcus A. Coolidge, president. Both concerns make non-conflicting products, and will continue to do so under the merger. The new firm will be known as the Seneca Falls Machine Co. and will continue to manufacture the Lo-Swing and the Star lathes and other machinery built at Seneca Falls and in Fitchburg for several years.

Germany Prepares for Renewed Activity in the Machine Tool Line

Every effort will be made to regain lost trade and prestige

Like all other of the great industries in which Germany had won world renown before the outbreak of the great war, the machine building industry is complaining most bitterly today of the very unfavorable state of business. This is due to two main causes, neither of which were apparent in the years when the depreciation of German currency went on so relentlessly, but which make themselves felt with manifold intensity now that the artificial prosperity of the inflation period has passed.

During the depreciation years, orders from abroad poured into Germany in a never-ending stream, but the industry was never able to realize that it was selling its products at paper mark prices far too low. The result was that foreign buyers, taking advantage of the splendid opportunity offered, bought machinery enough to cover all their demands for years to come.

While the depreciation over-stimulated the appetite of the foreign buyer, it killed the home market. Whereas in 1922 there were 750,000 workers engaged in the machine-making trades, in 1923 the number had fallen to 600,000. In May of this year, the standard of efficiency of the German works as a whole was only 50 per cent, while, in the case of the heavy tool making machine trade, it had fallen as low as 20 per cent. This was due to the decline of agriculture and industry in general, which necessitated fewer new machines, total cessation of all building trade operations, the result of rents being kept artificially low by the government, the restriction in means of communication and traffic, and the consequent lowered demand for tools of all kinds.

The Dawes Plan and Machine Tools

While in most branches of industry great hopes prevail that the acceptance of the Dawes plan and the loan which Germany is to receive in consequence, will bring about a much needed business revival, the opinion of leading men in the machine tool industry is not so optimistic. It is felt that, while the Dawes plan alters nothing as regards the obligations Germany has to meet under the Treaty of Versailles—in fact, in certain directions it even adds to these burdens—there is little chance of any stimulation of the home market, because there is no chance for industry to accumulate savings for extension of plant or modernization of works. The main market therefore will still be in foreign countries.

But here, too, the outlook is not bright. Other countries during the war realized the peril of their previous dependence on Germany, and set out to establish their own machine industries. To protect these new struggling industries, import tariffs were set up against German goods. The customs tariffs of France, Italy and Belgium are so high as to be all but impassable. Other countries, notably Austria and Hungary, forbid the entry of German machines altogether, in order to foster their own industries. Switzerland has adopted a similar policy, while Yugoslavia, a land whose requirements are very varied, is following the principle of ordering everything against reparations account. Sweden, Holland, Denmark and the United States have very harsh restrictions on import, Spain has a so-called Anti-Dumping Duty which has long since lost all shadow of justification, while another very important pre-war market, Russia, is all but inaccessible owing to the communistic control of trade.

Against many of these restrictions, Germany is planning a wholesale campaign. The government is driven to take a very active and practical interest in the welfare of its industry, since it is the industrialists that are to create the wealth out of which the future reparations payments are to be made. Until Jan. 10 Germany, under the Treaty of Versailles, is not permitted to make any trade agreements with other countries on the "Most Favored Nation" principle. All the Allied nations enjoy automatically every "most-favored" concession Germany grants to any nation whatever. That makes the whole principle illusory. But negotiations are very rapidly going on with all the customer nations for the signing of new trade treaties after Jan. 10. After this date, therefore, Germany will be in the position to force her way through many of the barriers now set up against her.

That, of course, will not end the battle. Germany at present is producing far too dearly. There is great difficulty in procuring raw material. Wages, which were very low in the days of the depreciation, are now constantly rising. Far more injurious, however, are the fabulous rates of interest and the bank charges now prevailing. In spite of a great deal of reduction, these will amount to an average of about 24 per cent per year against first class security. Then the "Turnover Tax" is a great burden on production. This amounts at present to two per cent on selling prices every time raw material, half-finished or finished goods changes hands. After passing through many hands, this tax makes up about 20 per cent of the value of any finished article. Finally, the standard of efficiency of the workers in the industry is much reduced as compared with pre-war days, and the hours of labor are, for the most part, only eight as compared with ten formerly.

On the world's markets, German industry today works at the immense disadvantage of being unable to give its customers any appreciable credit, whereas the American machine tool builders are often able to allow six months for payment. Negotiations are going on between the machine makers and the new Gold Discount Bank in Berlin with the object of devising a scheme by which these manufacturers will be able to import their raw materials through the bank, and pay only after the goods are re-exported as finished articles. The same institution is asked to arrange for the concession of long terms of payment by first class foreign customers.

Should these plans all mature, the German machine tool men believe that the well-known excellence of their productions will enable them to recover their place as suppliers of machinery to the world's markets. One thing they believe to have to their advantage that their newer rivals do not all possess—a highly developed and progressive industry in all other lines furnishing the machine-making trade for their own use with new designs on which development in machine making depends.

The markets in which Germany hopes to regain her footing most easily are South America, Japan, India, the Balkans, Czechoslovakia, Poland, and, when order is ultimately restored, Russia.

Few New Tools Shown at Exhibition of British Association

German machines are excluded at Olympia Show in London

The outstanding event for machine tool men in Great Britain of late has been the exhibition at Olympia, London, W., held from Sept. 5 to Sept. 27. Promoted by the Machine Tool Trades Association, the display is not so extensive as that of four years ago, and it has been found necessary to close the gallery, while three or four firms who literally "came in on the ground floor" have given up their spaces. Including a few Scottish productions, the tools shown are predominently English, plus a number of American tools and a smaller number of Swiss machines, with one or two French and Belgian tools.

While a British-made machine which was originally of German design may be seen, German exhibits were not permitted by the association, although it may be mentioned that two or three months ago at the Foundry Exhibition held in Birmingham they formed quite an important feature.

A preliminary survey would suggest that the tools exhibited are rather natural developments than a marked break from usual practice. They are of the small to medium-size order, manufacturers of heavy machine tools not being well represented in the association which promoted the exhibition. Special and single-purpose tools are not prominent and some few machines are of the same design as exhibited in 1920. Two or three stands of wood-working machinery are to be seen, and there are the usual accessory stands for small tools.

Except possibly as regards an American example or two, the developments in hydraulic drives and feeds which continental firms have devised are not in evidence, and the intimate co-operation between the machine tool man and the electrical engineer, to be seen in similar quarters, is also not very conspicuous.

There are of course exceptions, one being a planer with a table about 7x16 ft. long, and to admit 100 in. between the uprights, which with its electric machinery weighs about 48 tons. It is the largest machine shown. The drive is by a special three-machine system, providing in addition electric feeds, and by a magnetic device the tools can be relieved on the return stroke.

Has Two Motors

The electrical equipment has two motors, one of ordinary character taking supply from the mains and driving a special generator, which in return supplies a special motor driving the planer. By manipulation of its magnetic field, the generator can be caused to supply current at variable voltage and alternate polarity, and the special motor is independently excited, variation of the voltage of its supply causing variable speed in this motor, while the alternation of polarity provides for reversal of rotation. Without other switchgear, quick return is controlled by disk and master switch actuating two contactors. For this the shunt field windings, both of generator and special motor, are divided into two sections. On the generator these sections are in opposition; separately in use, they provide for reversal of dynamo polarity. On the motor the two field sections agree. One is permanently excited throughout the cutting stroke of the planer, strengthening the field and thus giving a slow cutting speed, with quick return on reduction of field strength. The machine exhibited provides cutting speeds that can be caused to range from 12 ft. to 90 ft. with a return at from 45 ft. to 180 ft. a minute. But even here an earlier example of the same general scheme was shown, the writer thinks, at the corresponding exhibition four years ago.

An hydraulic feature is to be found in a new universal forging machine which is intended to combine the smooth operation of the press with the speed and finish of the hammer. Here the piston is driven by a belt-actuated crank and works in a hollow ram to which it transmits a reciprocating motion by means of oil. The stroke of the ram is constant at 2½ in., but for striking purposes the actual position of the ram can be adjusted by 7 in., by means of a valve which permits the oil to move from one side of the piston to the other. A pressure of 150 tons, limited by relief valve, is obtained. The machine is shown in model only.

As has been suggested, in large proportion the machine tools exhibited are of standard form and mainly present improvements in detail, as, for instance, in lathe apron mechanism. The movement towards centralizing control shows extension. It is still markedly in evidence in the case of drilling machines and milling machines, and better means of control have also been applied to planers, etc. A new line of ball bearing sensitive drills, ranging from bench form to four-spindle upright types, has six speeds for each spindle, the maximum speed exceeding 10,000 r.p.m.

The British Engineering Standards Association has recently issued a report on limits and fits for engineering. In it it reverses the recommendation made some 18 years ago, the hole now being taken as the basis. Further, speaking generally it recommends the uni-lateral system, that is tolerance in one direction only from the nominal size, so that holes are either of nominal size or larger. The committee concerned made an inquiry into British practice in this connection, and found that out of 429 firms, about 70 per cent were using bi-lateral systems and 20 per cent uni-lateral, the remainder using both systems. It also inquired as to the system that would be adopted by firms if starting afresh. Out of 367 replies 56 per cent were in favor of the bi-lateral system. Nevertheless the committee has unanimously recommended the uni-lateral system "where it does not conflict with predominating present practice," the purpose being to give a lead to British industry towards uniform system.

Poland Wants Products from America

A short investigation into the commercial situation in Poland, largely in electrical and electric railway lines, however, shows that the Poles have made some subtantial progress in developing their new state—one evidence being the new currency and its stability since its creation. Poland's industry—in most lines other than textile—was not of course, at all unified or developed on a national scale, since the country is made up of three parts of separate political and economic background in recent years. But a good start has been made and there are definite programs under way in many lines.

As a possible market for American products there is this much to be said. Poland would like to trade with America, and now some of her people actually complain that there is no initiative from America, in fact that any market development in Poland, of American products, is done almost in spite of the American concerns. Poland does not want to import what she can make herself—and she puts high duties on those things. She does not like to buy from Germany, and will not if she can avoid it. She likes France and will trade there. But she wants some American goods, too.

The American should be warned, however, that he can do business only on a basis of consigned stock—with agency—in all but very heavy equipment in which a large time element of shipment is involved anyway. That is one feature of American trade with Poland that the Poles say most Americans do not appreciate.

Poland does not pretend to be rich. But she is successfully borrowing both French and British capital and intends to go ahead.

What the Railroads Are Doing

Loadings of freight crossed the million-car mark in the last week of August for the first time this year, due to a large increase in the shipments of coal, grain and merchandise, according to the figures made public by the Car Service Division of the American Railway Association. Compared with the loadings for the week before, the total loadings of 1,020,339 were an increase of 38,091 cars and 71,811 less than in the corresponding week of last year.

The American Locomotive Co. has received orders for twenty-five 165-ton mikado engines and ten 144-ton pacifics from the Missouri Pacific Ry.; nine 63-ton mikados from the Sorocabana Railway of Brazil and for general heavy repairs to twenty-five 220-ton mallets from the Chesapeake & Ohio R. R.

The Baldwin Locomotive Works received an order from the Jodhpur State Railway of India for five mikado type locomotives valued at approximately $125,000 and an order from Missouri Pacific R.R. for 15 switching locomotives valued at approximately $630,000, according to estimates.

The Chesapeake & Ohio R.R. has placed a contract with the Richmond Car Works for equipping 1,000 70-ton gondola cars with new bodies.

Railroads are coming into the market for substantial tonnages of both rails and steel for cars. A total of 17,400 cars are in the market and inquiries are also expected for 175 tons of rails from one road and 60,000 tons from another.

Announcement of one of the largest new equipment orders in recent months was made recently by the Pennsylvania Railroad Co. Although no figures were made public as to the value, the order was estimated as in excess of $30,000,000. The company's statement said: "Announcement was made that the Pennsylvania Railroad System has placed orders for the purchase of 10,000 new all-steel box cars for delivery at an early date." It was reported that the order had been divided, but that a substantial part of the contract had been awarded to the American Car & Foundry Co. and the Pressed Steel Car Co.

Several new orders for equipment were announced recently, among them one for 2,000 box cars, to cost approximately $5,000,000, which was awarded in equal lots by the Texas & Pacific Railway Co. to the American Car & Foundry Co. and the Pullman Co.

The American Car & Foundry Co. received an order for 200 box cars from the Central Vermont, and the General American Car Co. received one for 200 tank cars from the General Service Tank Cars, Inc.

The Philadelphia & Reading Ry. is inquiring for an additional 1,000 hopper cars, or 3,000 cars in all. This is the company's second order within a month.

The Business Barometer

This week's outlook in Commerce, Finance, Agriculture and Industry based on current developments

By Theodore H. Price
Editor, *Commerce and Finance*, New York

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LAST week the expected again failed to happen. Everyone had predicted an advance in the stock market if the Maine election favored the Republicans. The Republicans were successful but after a brief flutter stocks turned downward and as the week ends the market is rather feeble.

Several less important industrial corporations have followed the example of the American Woolen Co. by passing or reducing their dividends. It is suggested that the St. Paul Railway may have to "scale its capitalization," the stimulating effect of the Van Swearingen consolidation appears to have been discounted, and the Republican majority in Maine has not entirely allayed the fear that La Follette may get enough votes to throw the election of a President into the House.

Bonds are steady and a few new issues have been successfully placed, but there is a disposition to await the issue of the German loan, and Government securities are just a shade easier.

In the commodity markets wheat, corn and rye are higher. The Government reports published Tuesday did not indicate much change in the "productive expectancy" and were without any affect upon the markets, but Jack Frost came along on Wednesday night and his appearance caused a sharp bulge on Thursday. It is, however, doubtful whether a further advance in grain is desirable even for the farmers. The editor of the Emporia, Kansas, *Gazette* thinks not, for he writes that:

"The chickens can't afford to eat dollar corn. It takes a ten-cent hog to eat dollar corn, and there are no ten-cent hogs. The eight-cent steer doesn't dare touch dollar corn, or his owner will go into bankruptcy. It would be better for the Kansas farmer to bring his steer and hog to the best hotel in the State and keep them there rather than to feed dollar corn at the present price of live stock. The horse can't eat dollar corn and compete with fifteen-cent gasoline. And if the folks in the house try to eat dollar corn, they might better eat turkey and tropical fruit.

"Therefore," continues the *Gazette* editor, "It is no time to get excited about the large chunks of money the Kansas farmer is going to spend for diamond surcingles and pearl martingales for mother and the girls."

Wool and woolen goods are still rather slack, but the abnormally cool weather has quickened seasonal buying. There seems to be a world-wide scarcity of wool.

Generalizing it may be said that the individual American is buying thriftily. He must, for he is finding that it is impossible to stretch his dollar so that it will cover the increased cost of living due to the advance in the price of food, especially grain.

This thriftiness is salutary, but it does induce the elation among merchants that lavish buying and mounting sales evoke. This explains the disappointment of those who expected a boom and are depressed because business is about normal. The steel industry is a little more cheerful on an increase of orders due chiefly to the buying of the railroads and the public utility corporations. This buying, as previously pointed out, is due to the readiness with which big concerns in good standing can sell their bonds, and they are taking advantage of conditions to improve or increase their facilities.

But it must be admitted that in so far as new home building and automobiles are concerned it is likely to be a winter of restraint. This is certainly true in the larger cities of the East, however it may be in the West. In New York there is an oversupply of brick and of nearly all other building material except lumber, and the number of unrented apartments is increasing as those that were under construction are completed.

Because the demand for both skilled and unskilled labor is less exigent workmen are easier to obtain and it may be that we are running into one of the minor reactions that always follow periods of activity.

It is certain that there is no speculative initiative anywhere. Everone persists in buying from hand to mouth and on the Stock Exchange those who can "make a market" are continually asking "Why should I try to make money when the Government gets a third of my profits but refuses to share my losses?"

To the philosophical economist this attitude is reassuring rather than disturbing, but it makes the stock brokers blue and the financial reports published all over the country are colored accordingly.

But the Federal Reserve report shows that there is an abundance of credit and, although it is still being husbanded for use when the German loan is offered, it is a moral certainty that there will be no stringency of money this winter. To those whose business experience antedates the war and the Federal Reserve System this is very reassuring and it ought to assuage the disappointment that some feel because the boom that was predicted when corn and wheat went up has failed to arrive, and now seems unlikely to appear.

Political and financial conditions in Europe appear to be improving. There is an excellent export demand for our cotton and grain, but it may be that we shall have to take pay in merchandise rather than in money as gold seems to have stopped coming this way and we are shipping some of it to India where there appears to be great prosperity. Silver is a little higher because it is wanted in China to pay the soldiers or revolutionists who are ighting there.

What's Doing in Industry

Railroads bought much equipment during the past few weeks and machine tool men are of the opinion that it will not be long before both the railroads and the car builders are buying machinery and machine tools. The Pennsylvania and the Illinois Central railroads both bought freight cars and other roads bought large orders of steel and some machine tools.

The automobile industry is again ready to buy and dealers supplying this trade are watching with interest developments in the automotive centers. There are some indications that sales will be made during the coming two weeks.

While the general electrical trade has fallen off, business is still good and machine tool dealers are selling to the large electric companies in good volume. The future in this line looks even more promising.

General business has shown signs of revival and reports are to the effect that the fall has opened well in the retail trade.

The stock market was irregular during the past week with gains noted in many of the important stocks. Bonds sold well and in good volume.

The Industrial Review

Progress of the machinery and machine-tool business in various parts of the country

THE following reports, gathered from the various machinery and machine tool centers of the country, indicate the trend of business in these industries and what may be expected from the future:

New York

Railroads were the chief buyers in the New York market during the past week and orders were received from many of the roads with headquarters in the East. The Lackawanna, the Lehigh, the Long Island, the Pennsylvania and the New York Central were all purchasers for small orders with inquiries received from several other roads Dealers complain that the roads are not buying in large quantities and lists sent out several weeks ago are not being closed on. However, the future looks bright to the machine tool men as it is anticipated that the big electric companies including the Western Electric Co. and the International Telephone & Telegraph Co. will be in the market for tools before long. The two named companies have both received good sized orders from abroad for telephones which will probably be made in this country.

Another source which is expected to yield good business this fall is the builders of locomotives and freight cars. They are busy with orders of their own and new equipment is needed.

No new orders have been received from Eastern automobile makers during the week, although some accessories manufacturers have been inquiring for special tools.

A slight let-up in the demand for used tools was noted, but dealers claim that they do not have much excess on hand at the present time.

Exporting continues at a lively pace with every indication that the report for the twelve months will be at least 20 per cent better than last year. This will be the greatest gain ever recorded in export business, excluding the war period which was abnormal.

Detroit

With an automotive industry which has made up its mind not to try to reach new production totals and to break records during the fall and winter months, slowly but surely getting into a more stable condition, leaders in the machine tool and machinery fields in Detroit find but little change in the conditions that have prevailed during the past several weeks.

Sales remain spotty with business rather scattering. Inquiries are being received in fair quantities and a very good proportion are developing into sales. The tendency of most manufacturers to refrain from purchasing equipment other than actually needed in present production schedules has not helped the local market to any considerable extent.

August proved satisfactory to most of the larger dealers in Detroit, although none felt any undue elation when the totals were made. With September half over, representatives of machine tool firms appear more concerned with what October and November will bring forth than what September may bring.

The determination of the motor car industry to keep shy of over-production which caught so many last spring with thousands of cars on their hands is reflected in recent announcements. It has been learned that the Ford Motor Co. will continue a five-day week, as it has been found that production is almost as high for this period as during the six-day week. A number of other companies have been working five days a week and while not definitely committed to the policy will probably not average over 40 or 45 hours a week.

General business conditions as reflected in building totals, bank clearings, and postal receipts are considered to be on the up-grade in Detroit and the adjacent cities of the state.

Cleveland

Improvement in actual demand for machinery and machine tools which has been anticipated by Cleveland manufacturers and distributors for months, seems to have arrived. Not only have inquiries for a wide variety of equipment been received in the last week, but this move is substantiated by orders as well.

For the moment this improvement seems to be confined to the shear, planer and automatic divisions, though in other lines a like change for the better is noted also.

The most significant development may be considered the wider spread of inquiry for automatic equipment. This is coming in from foreign sources, one inquiry received here this week by one concern coming from New Zealand. In the main, however, this tendency is developing in the recognized industrial centers of the United States, particularly in the Central West and East, and is coming from quarters that have been hitherto conspicuously out of the market entirely. All these prospective users indicate that replacement of their equipment will be the natural aftermath of impending demand for their own output.

There is no letup in the jobbing work being done by tool makers and, in a few instances, night as well as day work in this field is being done. These same concerns that are taking on such work in lieu of sales of their regular machines are of the opinion, however, that as added outlet for their product develops, less of the jobbing work will be placed with them.

In the planer field a marked change for the better has come in the last ten days. More than one producer in this division states that more inquiries have been received in the last week than were received all told in the previous four months.

In other fields the lighter equipment, with a particular inquiry for sheet metal working equipment, is seen in the last fortnight.

Locally an encouraging phase has developed in the announcement by the White Motor Co. that construction of its new assembling plant at Louisville, Ky., will start before the end of September. The decision of the White to complete this project is based upon increased business in the South, and this in turn tends to bear out the contention of tool interests themselves that a revival of industrial activity in the South is at hand.

Cincinnati

Signs of increased activities are evident in the Cincinnati machine tool market. Volume of production for the month of August and the first half of September is considerably larger than that during July and this fact is an indication of the trend of business here. Manufacturers are unanimous in the belief that the improvement in sales will be slow, but there is a decidedly better tone to the market than a few weeks ago. There has been some railroad buying locally and sales have been reported to the Norfolk & Western and several other Eastern roads. There are lists out now for tools for Eastern railroads, but these are confined for the most part to small units. Executives believe that railroad purchases will be rather quiet in the next few weeks. Automobile manufacturers have been making some purchases, but the total volume of orders from the automotive industry has been below expectations. Manufacturers have been waiting for this business to break and are predicting that it will increase in the near future.

Purchases during the past two weeks among machine tool houses in Cincinnati have been mostly for small machines, no large orders being recorded. Buyers are pursuing a cautious policy and are displaying conservatism in their purchases. Specialized tools have been moving well lately. Manufacturers report that the general industrial field is not yielding a great deal of business at present.

Planer manufacturers state that their production has been maintaining a fair gait and that operations show a slight increase as compared with a month ago,

Milling machines, grinders and lathes are in fair demand. Conveying machinery houses have a good business and are running on a normal schedule that is about the same as this time in 1923. Executives state that the total volume of conveying machinery produced in the first eight months of this year is equal to that produced in the corresponding period last year. Woodworking machinery concerns are operating at capacity to fill orders. Electrical tool firms are increasing their production as the fall season opens up. Automobile accessory manufacturers report that their plants are busier than they were and that inquiries have been encouraging with sales showing an upward trend.

There has been an improvement in the metal trades and a larger number of orders are being booked by local foundries. Cincinnati plants are now running on a heavier schedule than they were during August.

Buffalo

There are signs that business is on the upward trend, which is bound to mean better machine tool business some time in the near future. For instance, the employment department of a local engineering society reports that it recently has placed at least a dozen draftsmen and has opportunities for several other professional men and skilled workers. The importance of this is in the fact that filling of such positions usually indicates that manufacturers are beginning preliminary work that eventually will call for purchases of mechanical equipment.

The American Body Co., a Buffalo concern making bodies for a number of well known automobiles, has leased one of the buildings owned by the Curtiss Aeroplane & Motor Co. In its new quarters the American Body Co. will occupy about 750,000 sq.ft. of floor space, an expansion that should call for some new machinery.

The Pierce Arrow Motor Car Co. is increasing production on its new model in order to keep up with demand from its dealers. Demand for its standard model, and trucks and buses is also reported to be increasing steadily. One good feature of Pierce Arrow's present activity, from the viewpoint of the machine salesman, is that any number of smaller machine shops about the city, which during the early summer were running very light, are now tremendously busy turning out parts for the lighter car. This has meant a steady, though small volume of business from these smaller shops.

Most departments of the American Radiator Co. are busy at this time, and some machine sales are reported.

Recent sales to the Salisbury Axle Co., Jamestown, were two large presses and several milling machines, besides some miscellaneous equipment and tools.

All these things are encouraging to the machine tool trade and lead to the belief that the latter part of this month will see a decided betterment of sales. A fair number of inquiries are out, with but few closing.

Recent sales noted in this territory include one large turret lathe, some smaller lathes, various pieces of small equipment of different types and some small punch and shear equipment. Several offices report sales of one or two pieces of milling equipment.

News of the Automotive Industry

Studebaker plants at South Bend, Ind., will employ 18,000 men by Oct. 1, according to A. R. Erskine, president of the Studebaker Corp. Fall and winter business is looked to for the addition of at least 3,000 men to the regularly employed, 15,000, Erskine said.

Automobiles shipped out of Lansing over the Michigan Central in August increased 100 per cent over July. The incoming shipments of auto accessories also showed a like gain, while incoming shipments of fuel, steel, gasoline, oils and other commodities increased materially.

Reports of Lansing manufacturing institutions indicate the city will enter the winter with practically normal production and labor conditions. At the Durant plant the entire production force added 15 working hours to the weekly schedule this week, making it 55 hours.

"More than 400,000 American motor cars and trucks will go to 114 foreign countries in 1924," says Alfred Reeves, manager of the National Automobile Chamber of Commerce. Automobile shows will be held in Paris, Berlin, Amsterdam, Brussels and London this fall, where hundreds of foreign dealers are expected to contract for American cars. It was only slightly more than a decade ago that total production of the American automobile industry was less than estimated exports of 1924. In 1923 when production was 485,000 vehicles, it had for the first time crossed the 400,000 mark.

The Apperson Automobile Co. has leased the physical property of the Haynes Automobile Co. for five years with privilege of renewal for an additional five years. Plan calls for organization of the Haynes Motor Corp. to lease and operate the property contingent on agreement of creditors of the Haynes Automobile Co. to accept a settlement of their claims.

The Muncie, Ind., Products Co., Muncie, Ind., a subsidiary of General Motors, will add 100 men to its working force immediately, bringing the total up to 1,200. When running at full capacity, the plant employs about 3,000 men. It has been adding gradually to its working force for several weeks. Many other manufacturing companies, whose plants have been operated on short time for several weeks, are planning to increase the number of their employees this month.

Shipments from the Franklin factory, Syracuse, during August exceeded shipments for the same month in three previous years. They were over 66 per cent greater than in August, 1923.

Business Items

The Wallingford Manufacturing Co., Wallingford, Vt., has been purchased by the American Fork & Hoe Co., Cleveland, Ohio, and will be operated by this company in the future.

Maxwell Spiro & Co., formerly of 30 Church St., New York City, have moved to larger quarters at the foot of Grove St., Jersey City, N. J. The concern expects to expand its business during the coming winter to include several new lines.

Damage estimated at $500,000 was caused by fire in the Vancouver shipyard recently when the plant of J. Coughlan & Sons, Ltd., and the Northwest Dredging Co.'s vessel Mudlark were destroyed. Plans are being formulated for the immediate re-building of the plant of the Coughlan company.

George F. Foss & Son, Montreal, have been appointed exclusive agents for the engine lathe line manufactured by the Boye & Emmes Machine Tool Co., Cincinnati, O.

Through the efforts of A. B. Turner of Boston, the directors of the Charles B. Bohn Foundry Co. and General Aluminum & Brass Manufacturing Co., both of Detroit, have agreed to merge their interests into one company to be known as the Charles B. Bohn Aluminum & Brass Manufacturing Co.

The H. B. Brown Co. factory at East Hampton, Conn., was totally destroyed by fire recently. The factory was used for the building of threader machinery, for threading bolts.

The Universal Wheel Corp. with a share capital of $100,000 and head office in Walkerville, Ontario, has been incorporated under Dominion charter. Privileges granted the company include the manufacture and sale of automobile accessories, principally disk wheels.

Stockholders and creditors of the Anderson Foundry & Machine Co., a subsidiary of the R. L. Dollings Co. of Indiana, will take charge of the plant of the company at Anderson and will undertake to operate it, according to the terms of an agreement reached in the Madison circuit court. It was further agreed that Winfield T. Durbin, formerly Governor of Indiana, who had been receiver of the Anderson Foundry & Machine Co. several months, will retain control of approximately $57,000 for payment to the preferred stockholders of the present company.

Federal incorporation has been granted in Canada to the New-Mobile Motor Car, Ltd. which is capitalized at $100,000 to carry on the business of manufacturers of carriages, buggies, wagons, automobiles and parts thereof, motors etc. Headquarters will be in Montreal.

The Pawtucket Falls Manufacturing Co. of Pawtucket, R. I., has purchased the bankrupt plant of the D. Goff & Sons, Inc., also of Pawtucket, and is planning to occupy it.

Personals

GEORGE R. WOODS, New York manager for R. S. Stokvis & Zonen, has returned from a trip to Halifax and Quebec which was curtailed in order that he could attend the machine tool exhibit at New Haven and the convention of the American Society for Steel Treating at Boston.

FRANK J. BAUMIS has been made vice-president in charge of the machinery department of Manning, Maxwell & Moore, Inc., New York City.

E. R. ANDERSON, formerly with the Hendey Machine Co., Torrington, Conn., in the Chicago office, has joined the sales force of the Stocker-Rumley-Wachs Co., Chicago.

SAMUEL G. EASTMAN, formerly with Pratt & Whitney Co. and also the Niles-Bement-Pond Co., Chicago office, has been elected president of the Belvidere Screw & Machine Co., Belvidere, Ohio.

R. C. CARTER has been elected president of the Latrobe Tool Co., Latrobe, Pa. He was formerly with the Whitman & Barnes Manufacturing Co., Akron, Ohio.

LOUIS M. STELLMAN has resigned as chief engineer of the H. H. Franklin Co., Syracuse, N. Y., to become consulting engineer of the Skinner Automotive Device Co., Inc., of Detroit, Mich. Mr. Stellman was with the Franklin Co. for fifteen years and is well known in automotive circles.

SAMUEL MUNCH, Hartford, Conn., has resigned as a director of the G. E. Prentice Co. of Berlin, Conn., and also has disposed of his stock in that company.

STANLEY COOPER has been made general advertising manager of the Fafnir Bearing Co., New Britain, Conn.

DR. ING. EDWARD SCHMIDT, engineer for the Limited Co., formerly the Skoda Works of Pilsen Czechoslovakia, is spending some months in the United States studying American shop practice. His family is with him and he is acting as delegate from the National Engineering Society of Czechoslovakia to the centennial celebrations of the Franklin Institute and the Rensselaer Polytechnic Institute.

E. A. BICKELL, treasurer of the Garvin Machine Co., New York, is on a trip to Quebec, Can.

J. CARLETON WARD, JR., has been promoted to be assistant manager of the Pratt & Whitney Manufacturing Co., Hartford, a subsidiary of the Niles-Bement-Pond Co. Mr. Ward is a graduate of the school of engineering of Cornell University. He went to Hartford six years ago.

C. E. CLARK, formerly treasurer, is the new president of the Howard Iron Works and the Alberger Heater Co., Buffalo, under the recent re-organization. C. Kneiser becomes vice-president and A. Talamo remains secretary. E. A. Hahl, chief engineer, assumes the additional duties of sales manager for the heater and expansion joint departments, replacing Mrs. O. E. Frank, resigned. These, and other employees of the company, have bought the controlling interest.

L. H. MESKER is now with the Cleveland Planer Co., Cleveland, Ohio.

LOUIS W. BYRNE, formerly with the Wilmarth & Morman Co., Grand Rapids, Mich., has been appointed general manager of the Delahunty Dyeing Machine Co., Pittston, Pa.

J. C. AYRES has been appointed general sales manager of the Gotfredson Truck Corp. of Detroit. He was formerly with General Motors, Republic, Denby and Federal.

RUSHMORE B. HEED has been appointed vice-president and general sales manager of the Garford Motor Truck Co. of Lima, Ohio.

IRVING W. CARTER becomes the heir to the Edward T. Carter Brass Foundry Co., of Plainville, Conn., under the terms of the will of his father, Edward T. Carter, who died recently in Vermont. The business has been carried on by the family for sixty years.

PERCY M. BROTHERHOOD has been made a consulting engineer with Manning, Maxwell & Moore, Inc., New York City.

H. D. ROHMAN of the R. C. S. Equipment Co., 8 East 41st St., New York City, has been appointed an agent for the Electric Arc Cutting & Welding Co., Newark, N. J.

MRS. O. E. FRANK, formerly sales manager of the heater and expansion joint departments of the Howard Iron Works and the Alberger Heater Co., both of Buffalo, has organized the O. E. Frank Heater & Engineering Co., Buffalo.

F. M. LONG, of the Gisholt Machine Co., Madison, Wis., sailed for Europe, Sept. 4 on a business trip.

NELSON LITTELL, formerly an examiner in the metallurgical and chemical division of the United States Patent Office, has recently become a member of the firm of Hammond & Littell, patent lawyers, New York.

AUGUSTUS WOOD has been made works manager of the Putnam Machine Co. plant of Manning, Maxwell & Moore, Inc., Fitchburg, Mass.

Pipe Specifications Approved by A.E.S.C.

The American Engineering Standards Committee announces the approval, as Tentative American Standards, of A. S. T. M. Specifications for Welded and Seamless Steel Pipe and Welded Wrought-Iron Pipe.

The A. S. T. M. initiated the work on specifications for steel pipe, in 1915, and on wrought-iron pipe, in 1918.

In 1921 the work broadened to include seamless as well as welded pipe, and modified to bring them in accordance with the American Standard Pipe Thread.

The action by the A. E. S. C. on approval was taken in accordance with the recommendation of a special committee under the chairmanship of Stanley G. Flagg, Jr.

Obituaries

AARON JACOBS, secretary and one of the founders of the American Foundry & Machine Co., Hamilton, Ohio, died recently. Mr. Jacobs underwent an operation last February and did not recover from its effects. He was born in Cincinnati and was associated with the Mosler Safe Co. of Hamilton. In 1900 he left that firm and assisted in founding the American Foundry & Machine Co. He was 56 years old at the time of his death.

HERMAN LIFCHITZ, president of the H. Lifchitz Foundries & Machine Works, died recently at his home in Indianapolis, Ind.

WILLIAM BENJAMIN WATKINS, president and treasurer of the Watkins Commercial Body Corp., Buffalo, died recently at his home at Angola-on-the-Lake, near Buffalo.

Gage Steel Committee Meeting

There will be a meeting of the Gage Steel Committee in Boston, at the Copley Plaza Hotel on Monday, Sept. 22 at 8 p.m. daylight saving time. Service and laboratory wear tests will be reported on and plans will be made for continuing the work of the committee.

Forthcoming Meetings

Franklin Institute. Centenary celebration of the founding. Philadelphia. Sept. 17, 18 and 19. The Hall of Franklin Institute, 15 S. Seventh St. Gellert Alleman, chairman of the executive committee.

American Society for Steel Treating. Sixth Convention, Boston, Mass., Sept. 22, 23, 24, 25 and 26. W. H. Eisenman, secretary, 4600 Prospect Ave., Cleveland, Ohio.

National Association of Cost Accountants. Annual convention, Springfield, Mass., Sept. 22, 23, 24 and 25. S. C. McLeod, secretary, 130 W. 42nd St., New York City.

National Safety Council. Thirteenth Annual Safety Congress. Louisville, Ky. Sept. 29 to Oct. 3. W. H. Cameron, managing director, 168 N. Michigan Ave., Chicago.

Motor and Accessory Manufacturers' Association. Annual meeting, Cleveland, Ohio. Week of Oct. 6, 1924.

American Foundrymen's Association. Twenty-eighth annual convention. Milwaukee, Wis. Week of Oct. 13, 1924.

National Industrial Advertisers Association. Annual meeting, Edgewater Beach Hotel, Chicago, beginning Oct. 13, 1924.

Management Week. Under the auspices of the American Society of Mechanical Engineers. Week of Oct. 20, 1924. Simultaneously held in leading cities.

American Gear Manufacturers Association. Semi-annual fall meeting. Briarcliff Lodge, Briarcliff Manor, N. Y., Oct. 16, 17 and 18. J. W. Owen, secretary, 4443 Prospect Ave., Cleveland, Ohio.

Society of Automotive Engineers. Production meeting. General Motors Building, Detroit, Mich., Oct. 22, 23 and 24. C. S. Clarkson, secretary.

American Society of Mechanical Engineers. Forty-fifth annual meeting. New York City. Dec. 1 to 4. Calvin Rice, secretary. 29 West 39th St., New York City.

National Exposition of Power and Mechanical Engineering. Grand Central Palace, New York City, Dec. 1 to 4. Charles F. Roth, 1102 Grand Central Palace Building, New York City.

Exposition of Invention. Engineering Societies Building, 29 West 39th St., New York City. Dec. 8 to 13 inc. General offices, 47 West 34th St., New York City.

The Weekly Price Guide

Rise and Fall of the Market

Iron and Steel—Pig iron output is on the increase; reserve yard stocks, however, are being gradually consumed. Iron price is about 50c. per ton above Sept. 5 level, for No. 2 foundry, Southern. Iron and steel scrap, blue-annealed steel sheets and railway materials are decidedly firmer. Steel bars and shapes, however, have dropped about 5c. per 100 lb. since Sept. 5.

Non-Ferrous Metals—Zinc and tin firmer due to higher prices abroad. Lead export demand active; market stronger. Antimony has shown no actual advance since Sept. 5, despite unsettled conditions in China.

Linseed Oil—Raw oil quoted, Sept. 10, at $1.04, f.o.b., New York in 5 bbl. lots, as against $1.07 per gal., Sept. 5, 1924.

(All prices as of Sept. 12)

IRON AND STEEL

PIG IRON—Per gross ton—Quotations compiled by The Matthew Addy Co.:

CINCINNATI	
No. 2 Southern	$22.05@22.55
Northern Basic	20.00
Southern Ohio No. 2	21.77
NEW YORK—Tidewater Delivery	
Southern No. 2 (silicon 2.25@2.75)	28.05
BIRMINGHAM	
No. 2 Foundry	18.00@18.50
PHILADELPHIA	
Eastern Pa., No. 2x (silicon 2.25@2.75)	21.77@22.27
Virginia No. 2	28.44@29.44
Basic	20.00@21.00
Grey Forge	21.22
CHICAGO	
No. 2 Foundry local	20.00
No. 2 Foundry, Southern (silicon 2.25@2.75)	25.05
PITTSBURGH, including freight charge from Valley	
No. 2 Foundry	22.77
Basic	22.77
Bessemer	25.26

IRON MACHINERY CASTINGS—Cost in cents per lb. of 100 flywheels, 6-in. face x 24-in. dia., hub not cored, good quality gray iron, weight 275 lb.:

Detroit	6.75
Cleveland	4.75@5.00
Cincinnati	5.00@7.50
New York	5.00@5.50
Chicago	5.25@5.75

SHEETS—Quotations are in cents per pound in various cities from warehouse; also the mill base in large lots.

Blue Annealed	Pittsburgh Mill Base	New York	Cleveland	Chicago
No. 10	2.65@2.70	3.89	3.55	3.80
No. 12	2.75@2.80	3.94	3.60	3.95
No. 14	2.85@2.90	3.99	3.65	4.00
No. 16	3.05@3.10	4.09	3.75	4.10
Black				
Nos. 17 and 21	3.35	4.40	4.25	4.55
Nos. 22 and 24	3.40	4.45	4.30	4.55
Nos. 25 and 26	3.45	4.50	4.35	4.60
No. 28	3.50	4.60	4.45	4.50
Galvanized				
Nos. 10 and 11	3.60	4.60	....	4.60
Nos. 12 and 14	3.70	4.70	....	4.70
No. 17 and 21	4.00	5.00	....	5.00
Nos. 22 and 24	4.15	5.15	5.00	5.15
No. 26	4.30	5.30	5.25	5.30
No. 28	4.60	5.60	5.55	5.50

WROUGHT PIPE (Welded)—Warehouse discounts are as follows:

	New York Black	New York Galv.	Cleveland Black	Cleveland Galv.	Chicago Black	Chicago Galv
1 to 3 in. steel butt welded	48%	34%	55½%	43½%	56%	43%
2½ to 6 in. steel lap welded	44%	30%	53½%	40½%	53%	40%

Malleable fittings: Classes B and C, banded, from New York stock sell at list plus 4%; class A, plus 23%. Cast iron, standard sizes, 36% off.

SEAMLESS STEEL TUBING—Following base discounts are on 20 gauge or .035-in., round, cold-drawn tubing, ¼-in. to 1-in., O.D., weighing 0.17 lb. to 0.36 lb. per ft. Cutting charge per 100 cuts, $1.50 to $1.58:

O.D. Inches	List Price per ft.	Differential Discount	O.D. Inches	List Price per ft.	Differential Discount
¼	$0.09	50%	⅞	$0.16	35%
⅜	.11	45%	1	.18	31%
½	.14	40%			

NOTE—The discounts are to be lowered by the following differentials in the case of regular .10-.20 carbon: 25,000 ft. or over, 83; 15,000 to 25,000 ft., 82; 5,000 to 15,000 ft., 81; 1,000 to 5,000 ft., 80; less than 1,000 ft., 79.

MISCELLANEOUS—Warehouse prices in cents per pound in 100-lb. lots:

	New York	Cleveland	Chicago
Open hearth spring steel (base)	4.50	6.00	4.20
Spring steel (light) (base)	7.00	6.00	6.00
Coppered Bessemer rods (base)	7.50	8.00	6.55
Hoop steel	4.49	3.85@4.35	4.15
Cold rolled strip steel	7.00	8.25	7.15
Floor plates	5.55	4.60	5.50
Cold drawn shafting or screw	4.15	4.00	3.80
Cold drawn flats, squares	4.65	4.50	4.30
Structural shapes (base)	3.34	3.20	3.10
Soft steel bars (base)	3.24	3.10	3.00
Soft steel bar shapes (base)	3.24	3.11	3.00
Soft steel bands (base)	3.99	3.20	3.65
Tank plates (base)	3.34	3.42½	3.10
Bar iron (2.90@3.00 at mill)	3.24	3.21	3.00
Tool steel	11.00	....	....
Drill rod (from list)	60%	40@55%	50%

Electric-welding wire, New York, 5/32, 8.35c.; ⅛, 7.85c.; 5/32 to ¼, 7.35c. per lb.

METALS

Current Prices in Cents Per Pound

Copper, electrolytic (up to carlots), New York			14.00
Tin, 5-ton lots, New York			51.50
Lead (up to carlots), St. Louis	7.90@7.95	New York	8.62½
Zinc (up to carlots), St. Louis	6.22½	New York	7.00

	New York	Cleveland	Chicago
Aluminum, 98 to 99% ingots, 1-15 ton lots	27.10	28.00	28.50
Antimony (Chinese), ton spot	11.50	13.00	10.00
Copper sheets, base	20.62½	20.87½@21.25	23.00
Copper wire, base	19.00	19.00	21.75
Copper bars, base	19.87½	22.25	22.50
Copper tubing, base	22.75	28.00	25.75
Brass sheets, base	17.25	21.75	19.75
Brass tubing, base	21.50	28.00	28.25
Brass rods, base	15.00	17.75	17.50
Brass wire, base	17.75	21.75	20.25
Zinc sheets (casks)	10.60	11.10	....
Solder (½ and ½), (case lots)	38.50	35.00	30.00
Babbitt metal (83% tin)	60.00	63.00	48@52
Babbitt metal (35% tin)	28.00	19.00	23@26
Nickel (ingot and shot) f.o.b. refinery	27.00	....	....
Nickel (electrolytic) f.o.b. refinery	30.00	....	35.00
Nickel (F shot) f.o.b. refinery	30.00	....	....

SPECIAL NICKEL AND ALLOYS—Price in cents per lb., f.o.b. Huntington, W. Va.:

Rolled nickel sheet (base)	52.00
Hot rolled rods, Grade "A" (base)	50.00
Cold drawn rods, Grade "A" (base)	58.00

Shop Materials and Supplies

METALS—Continued

Manganese nickel hot rolled rods "E"—low manganese (base) 54.00
Manganese nickel hot rolled rods "D"—high manganese (base) 57.00

Base price of monel metal in cents per lb., f.o.b. Huntington, W. Va.:

Shot	32.00	Hot rolled rods (base)	40.00
Blocks	32.00	Cold drawn rods (base)	48.00
Ingots	38.00	Hot rolled sheets (base)	42.00

OLD METALS—Dealers' purchasing prices in cents per pound:

	New York	Cleveland	Chicago
Crucible heavy copper	10.75@11.25	11.50	9.50@10.00
Copper, heavy, and wire	10.50@11.00	10.75	11 00
Copper, light, and bottoms	9.25@ 9.75	9.25	8.00@8.25
Heavy lead	6.25@ 6.75	6.00	5.00@5.50
Tea lead	5.25@ 5.75	4.50	3.00@3.25
Brass, heavy, yellow	6.75@ 7.00	6.50	6.00
Brass, heavy, red	8.50@ 8.75	....	7.50
Brass, light	5.75@ 6.00	5.50	5.00
No. 1 yellow rod turnings	7.25@ 7.75	7.00	6.00
Zinc	3.75@ 4.00	3.75	4.00

TIN PLATES—American Charcoal—Bright—Per box.

		New York	Cleveland	Chicago
"AAA" Grade:				
IC,	20x28, 112 sheets	$23.50	$22.85	$21.00
"A" Grade:				
IC,	20x28, 112 sheets	19.00	18.00	17.00
	Coke Plates—Primes, 20x28 in.			
100-lb.,	112 sheets	13.00	13.00	12.75
	Terne Plates—Small lots, 8-lb. Coating			
IC,	14x20	7.75	6.55	6.50

MISCELLANEOUS

	New York	Cleveland	Chicago
Cotton waste, white, per lb.	$0.14@0.21	$0.19	$0.14
Cotton waste, colored, per lb.	.09@ .14½	.18	.10½
Wiping cloths, 13½x13½, per lb	11@11.25*	36.00 per M	.16
Wiping cloths, 13½x20½, per lb.	....	52.00 per M	.16
Sal soda, per 100 lb.	2.40	2.25	2.65
Roll sulphur, per 100 lb.	3.60	3.25	3.50
Linseed oil, per gal., 5 bbl. lots	1.04	1.16	1.05
Lard cutting oil, 25% lard, per gal.	.55	.50	.32
Machine lubricant, medium-bodied (50 gal. wooden bbl.), per gal.	.29	.35	.21
Belting—Present discounts from list in fair quantities (½ doz. rolls).			
Leather—List price, 24c. per lin. ft. per inch of width for single ply.			
Medium grade	40–2½%	30–10%	30–10%
Heavy grade	30–5%	30%	20–5–2½%
Rubber transmission:			
First grade	50%	50–10%	40–10%
Second grade	50–10%	60–5%	60–5%
Abrasive materials—In sheets 9x11 in., No. 1 grade, per ream of 480 sheets:			
Flint paper	$4.86	$5.84	$6.48
Emery paper	10.71	11.00	8.80
Emery cloth	28.00	31.12	29.48
Emery disks, 6 in. dia., No. 1 grade, per 100:			
Paper	1.49	1.24	1.40
Cloth	3.38	2.67	3 20
Fire clay, per 100 lb. bag	....	.65	.60
Coke, prompt furnace, Connellsville	per net ton		3.00@3.25
Coke, prompt foundry, Connellsville	per net ton		4.25@4.75
White lead, dry or in oil	100 lb. kegs		New York, 14.75
Red lead, dry	100 lb. kegs		New York, 14.75
Red lead, in oil	100 lb. kegs		New York, 16.25

*White, at washery.

Comparative Warehouse Prices

New York	Unit	Current Price	Four Weeks Ago	One Year Ago
Soft steel bars	per lb.	$0.0324	$0.0324	$0.0354
Cold finished shafting	per lb.	0.0415	0.0415	0.0465
Brass rods	per lb	0.15	0.1475	0.1675
Solder (½ and ½)	per lb.	0.385	0.375	0.295
Cotton waste	per lb.	14@.21	.14@.21	10@13
Washers, cast iron (⅛ in.)	per 100 lb.	6.50	6.50	6.50
Emery, disks, cloth, No. 1, 6 in. dia.	per 100	3.38	3.38	3.38
Lard cutting oil	per gal.	0.55	0.55	0.55
Machine oil	per gal.	0.29	0.29	0.297
Belting, leather, medium	off list	40–2½%	40–2½%	30–10%
Machine bolts up to 1x30 in.	off list	50%	50%	40–10%

SHOP SUPPLIES

Current Discounts from Standard Lists

	New York	Cleveland	Chicago
Machine Bolts:			
All sizes up to 1x30 in.	50%	60–10–5%	60%
1½ and 1½x3 in. up to 12 in	15%	.....	....
With cold punched hex. nuts up to 1 in. diam. (plus std. extra of 10%)	40%	$3.50 net	.....
With hot pressed hex. nuts up to 1x30 in. (plus std. extra of 10%)	45%	3.50 net	60%*
Button head bolts, with hex. nuts	10%	List net	.....
Hex. head and hex. nut bolts	10%	.....	.....
Lag screws, coach screws	50%	.....	65%
Square and hex. head cap screws	75%	75–10%	.....
Carriage bolts, up to 1 in. x30 in.	40%	60%	55%
Bolt ends, with hot pressed nuts	50%	.....	60%
Tap bolts, hex. head, list plus	35%	.....	$4.65
Semi-finished nuts, ⅜ and smaller	70%	.....	.....
Semi-finished nuts, ½ and larger	65%	70%	.....
Case-hardened nuts	50%	.....	.....
Washers, cast iron, ½ in., per 100 lb. (net)	$6.50	$4.00	$3.75
Washers, cast iron, ⅝ in., per 100 lb. (net)	5.50	4.00	3.75
Washers, round plate, per 100 lb. Off list	1.50	4.75	4.50
Nuts, hot pressed, sq., per 100 lb. Off list	1.50	4.00	4.00
Nuts, hot pressed, hex., per 100 lb. Off list	1.50	4.00	4.00
Nuts, cold punched, sq., per 100 lb. Off list	1.50	4.00	4.00
Nuts, cold punched, hex., per 100 lb. Off list	1.50	4.00	4.00
Rivets:			
Rivets, ⅞ in. dia. and smaller	50%	60–10%	70%
Rivets, tinned	50%	60–10%	70%
Button heads ½-in., ⅝-in., 1x2 in. to 5 in., per 100 lb. (net)	$5.00	$3.50	$3.50
Cone heads, ditto (net)	5.20	3.60	3.70
1½ to 2-in. long, all diameters, *EXTRA* per 100 lb.	0.25	.....	0.15
⅝ in. diameter *EXTRA*	0.35	.....	0.15
½ in. diameter *EXTRA*	0.75	.....	0.50
1 in. long, and shorter *EXTRA*	0.75	.....	0.50
Longer than 5 in. *EXTRA*	0.50	.....	0.25
Less than 200 lb. *EXTRA*	0.50	.....	0.50
Countersunk heads *EXTRA*	0.45	.....	.....

*Square.

Machine Requirements and Industrial Construction

Machine Tools and Equipment Wanted

Conn., Bridgeport—The Bridgeport Brass Co., East Main St.—slitting shears for sheet metal work.

Ill., Streator—R. B. Patch, 605 East Wilson St.—one 3½ Whiting cupola, tumbling barrel and 10 ton electric crane (used).

Ind., New Castle—Indiana Rolling Mills Co.—machines for manufacture of steel products.

Ky., Louisville—U. S. Engineer's Office, P. O. Box 72—one electric welding outfit complete, 200 amps.

Mass., Boston—Schoolhouse Dept., City Hall—metal and woodworking machinery for manual training department for Samuel Adams District School, East Boston.

Mass., Brockton—Mawhinney Last Co., Montello—mortiser and tenoner machines.

Mass., Revere (Boston P. O.) — School Board—metal and woodworking machinery for manual training department for New High School.

Mass., Winthrop (Boston P. O.)—Bd. of Selectmen—metal and wood working machinery for manual training department for new Junior High School.

Miss., Lyman—Ingram-Day Lumber Co. —plaining mill machinery.

N. Y., New York—Noble Machinery Co., Inc., 237 Lafayette St.—Brown and Sharpe automatic screw machines.

O., Cleveland—The C. W. Stran and Son Co., 1288 East 9th St.—36-in. squaring shears for sheet metal work.

Ore., Portland—The Steel Tank and Pipe Co. of Oregon, F. W. Small, Gen. Mgr., c/o West Coast Iron and Steel Works, 28th and Nicoli Sts.—engines, lathes, drills, milling machines and a complete outfit for a large machine shop and boiler works.

Va., Richmond — The Chesapeake and Ohio R.R. Co., 823 East Main St., R. M. Nelson, Purch. Agt.—two squaring shears for sheet metal work and one hand power slitting shear.

Wis., Columbus—W. T. Jones—grinder, lathe, drill press.

Wis., Green Bay—Badger Show Case Co., 1100 South Broadway—woodworking machinery

Wis., Green Bay—Fox River Motor Car Co., 417 Main St.—boring machine and drill press.

Wis., Milwaukee — Milwaukee Tack Co., 27th and Wahl Aves., R. Lohse, Purch. Agt.—one medium size punch press.

N. B., Albert—Bonny River Lumber Co., North Hopewell Hill.—gang and rotary saws, lath machines etc.

Ont., Brockville—Hillside Garage Co., Schofeld Ave., W. H. Firth, Purch. Agt.—equipment for garage and repair shop.

Ont., Enterprise—W. S. Fenwick & Son—small lathe, drill press

Ont., Gananoque—B. Howe, King St.—drill press, vulcanizer, etc.

Ont., Hastings—Doxsee Bros.—saw table, pony planers and rip saw.

Ont., Havelock—E. Spencer, R.R. No. 2—saws, planer, edgers, etc.

Ont., Lakefield — N. A. Moore — pony planers and band saw.

Ont., North Bay—P. F. Doyle, 38 First Ave.—miscellaneous machinery for garage.

Ont., Osgoode Station — D. Blair—drill press and grinder.

Ont., Penetanguishene—P. Papette & Co. (machine shop) lathe, drill and various tools.

Ont., Walkerville—The Universal Steel Wheel Corp., Ltd., R. H. Hodson, Big Beaver, Mich., Purch. Agt.—complete equipment for the manufacture of disc wheels and automobile accessories.

Opportunities for Future Business

Calif., Berkeley—Premier Spring and Bed Co., 2401-17th St., San Francisco, having plans prepared for the construction of a 2 story factory on 3rd St. and Bancroft Way. Estimated cost $150,000. O'Brien Bros., Inc., 315 Montgomery St., San Francisco, Archts.

Calif., Los Angeles—R. D. King, Van Nuys Bldg., Archt., is receiving bids for the construction of 3 and 5 story, 150 x 180 ft. garage and office buildings on Sycamore and Hollywood Blvd., for H. P. Rehbein, 7038 Hollywood Blvd.

Calif, San Francisco—Diamond Patent Showcase Co., Inc., 1625 Mission St., are having plans prepared for the construction of a 1 story factory on Folsom and 8th Sts. Estimated cost $50,000. J. P. Shaffer, 987 Mission St., Archt.

Calif., San Francisco — Pacific Electric Mfg. Co., 827 Folsom St., plans the construction of a 1 story factory on Keith and Donner Ave. Estimated cost $45,000. Private plans.

Conn., Bridgeport — The Armstrong Manufacturing Co., will build an addition to plant for blacksmith shop on Knowlton Ave., Estimated cost, $8,000.

Conn., Hartford—H. K. Noyes & Son, Inc., Pearl St., plans the construction of a 2 story, 100 x 350 ft. garage and service station on Washington St. Estimated Cost, $150,000 to $160,000. Private plans.

Conn., New Britain—Vulcan Iron Works, 63 John St., awarded the contract for the construction of a 3 story, 80 x 277 ft. and 80 x 100 ft. factory, including an annealing room on John St.

Conn., New Haven—Biever Motor Co., 1079 Chapel St., awarded the contract for the construction of a 1-story garage on Whalley Ave. Estimated cost $150,000. Noted Sept. 11.

Ind., New Castle — Indiana Rolling Mills Co., plans the construction of an addition to 1 story steel plant. Estimated cost $50,000.

Ia., Davenport—Larenson Harvester Co., plans the construction of a 1 story, 60 x 200 ft. factory on West and Davenport Sts. Private plans.

Md., Baltimore—Baltimore Copper Smelt & Rolling Co., Highlandtown (Baltimore P. O.), will build a 1 story 312 x 428 ft. manufacturing plant on 2nd and 5th Sts. Estimated cost, $200,000. Private plans.

Md., Baltimore—Montgomery Ward & Co., Chicago Ave., and Larre St., Chicago, awarded the contract for the construction of an 8 story plant on Lincoln Highway. Estimated cost $2,000,000. Noted Aug. 29.

Md., Baltimore — The Reed and Fibre Products Co., 7 East Pratt St., plans the construction of a 1 story factory on Eighth and Monument Sts.

Mass., Boston — E. Clayton—11 Beacon St., is having plans prepared for the construction of a 2 story garage and show room. Estimated cost $200,000. Silverman, Brown & Heenan, 51 Cornhill, Archts.

Mass., Fall River—Terry and Crawford, Blossom St., awarded the contract for the construction of a 1 and 2 story, 50 x 140 ft. blacksmith and repair shop. Estimated cost $40,000.

Mo., St. Louis—Broad-Wal Garage Co. Planters Bldg., awarded the contract for the construction of a 3 story, 127 x 173 ft. garage on Broadway and Walnut. Estimated cost, $150,000.

Mo., St. Louis—People's Motorbus Co., 585 Adelaide Ave., is receiving bids for the construction of a 2 story garage and service building on Iron St., also a 2 story garage in the Western part of the city. Total estimated cost $300,000. Private plans.

Mo., St. Louis — Rieffling Auto Co., 2331 South Jefferson St., will soon receive bids for the construction of a 2 story 75 x 120 ft. auto repair and service shop, estimated cost $75,000. E. J. Hess, 3228 Magnolia Ave., Archt.

O., Mansfield—Westinghouse Elec. and Mfg. Co., East Pittsburgh, Pa., awarded the contract for the construction of a 1 and 4 story addition, to manufacturing plant.

O., Salem—Victor Stove Co., 208 Depot St., plans the construction of a 2 story addition to factory. Estimated cost $40,000.

Ore., Portland—The Steel Tank and Pipe Co. of Oregon, F. W. Small, Gen. Mgr., c/o West Coast Iron and Steel Works, 28th and Nicoli Sts., plans the construction of shops, yard and complete plant on a 15½ acre site. Estimated cost from $500,000 to $750,000.

Pa., Johnstown—Board of Education will receive bids until Sept. 25, for the construction of a 4 story Central High School including shops, on Somerset and Napoleon St. J. E. Adams, Johnstown and E. L. Tilton, 141 E. 45th St. New York, Archts.

Pa., Philadelphia—Olney Foundry Co., will build a 1 story addition to foundry on Duncannon and Mascher Sts. Estimated cost $25,000.

R. I., Providence—Providence Gas Light Co. is having plans prepared for the construction of a 3 story garage and service building on Potter Ave., and Dexter St., Jenks & Ballou, 1035 Grosvenor Bldg., Engrs.

Wis., Green Bay—Badger Show Case Co., 1100 South Broadway will build a 1 story, 100 x 110 ft. factory. Estimated cost $40,000.

Wis., North Milwaukee—Lakeside Bridge and Steel Co., 33rd St. and Villard Ave., plans the construction of a 1-story, 172 x 400 ft. shop. A. L. Seidenschwartz, 290 3rd St., Milwaukee, Archt.

Ont., Cooksville—Cooksville Shale and Brick Co., Ltd., plans the construction of a machine shop and plant. Estimated cost approximately $200,000.